

THOR Delivery Document

Checkout and Launch Control System (CLCS)

84K00150-002

NOTE: See "Supporting Document Note" on following page

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Jeffrey D. Wheeler, NASA, User Liaison CLCS	Date
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Kirk Lougheed, Chief System Engineering & Integration CLCS	Date
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Design Panel 1 Assessment Signoff

Description	Date	Thread Lead	System Engineering & Integration
Gateway Open System Pathfinder	___/___/___		
HCI/CCP/DDP Open System Pathfinder	___/___/___		
Business and Information Network Pathfinder	___/___/___		
Performance Modeling	___/___/___		
Regression Testing Phase 1 Pathfinder.	___/___/___		
Test Application Scripts Pathfinder	___/___/___		
Hypergolic Maintenance Facility IPT	___/___/___		
Super Light Weight Tank IPT	___/___/___		
Orbiter Power Up Down IPT	___/___/___		
System Capability Thread.	___/___/___		
System Stress Test Thread	___/___/___		
End to End Gateway Data Demonstration Thread	___/___/___		
Ground Support Equipment and Common Gateway Completion Thread	___/___/___		
PCM Support Thread			

	___/___/___		
Launch Data Bus Interface Phase 1 Thread	___/___/___		
LIVIS/CWLIS, IVHM, Fuel Cell Monitor and other Consolidated Data Thread	___/___/___		

Design Panel 1 Assessment Signoff

Description	Date	Thread Lead	System Engineering & Integration
Commanding and Command Processor Phase 2 Thread	___/___/___		
Data Distribution Completion Thread	___/___/___		
Reliable Messages Completion Thread	___/___/___		
System Integrity Phase 1 Thread	___/___/___		
System Viewers Thread	___/___/___		
End Item Manager, Prerequisite Control Logic and Application Interface Thread	___/___/___		
Simulation Gateway Phase 2 Thread	___/___/___		
Near Real-time Advisory Thread	___/___/___		
Advanced Retrieval Thread	___/___/___		
Constraint Manager Phase 1 Thread	___/___/___		
Data Health Completion Thread	___/___/___		
Data Fusion Completion Thread	___/___/___		
Log Record and Retrieval Phase 1 Thread	___/___/___		
Consolidated Shuttle Data Stream Gateway	___/___/___		

Shuttle Data Center- CDS Re-platform	___/___/___		
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Strategic Engineering System Integration and Test
CLCS Project

PREPARED BY:

Jeffrey D. Lee USA

Supporting Document Note: Acronyms and definitions of many common CLCS terms may be found in the following documents: CLCS Acronyms 84K00240 and CLCS Project Glossary 84K00250.

REVISION HISTORY

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Draft 0.0	Not Ready Yet	12/5/97
Draft 0.0	Not done	5/15/97
Draft 0.1	Getting there	6/24/97
Draft 0.2	Threads ready for review	6/27/97
Draft 0.3	Working Baseline Review Copy	6/30/97
Draft 0.4	Working Baseline Add change from SE&I (JW, JL), R. Esposito, M. Dotterweich	7/11/97
Draft 0.5	More Changes J.W.	7/12/97
Draft 0.6	Review Panel, removed Uplink, added System Integrity, combined Commanding and Command Processing, remove Test Build Phase 2, remove NT/HCI Pathfinder, re-scope Application Scrip Pathfinder, rewrite End Item Manager, rename and edit most threads, add text for Shuttle data center, inputs from R. Hart,	7/20/97
Draft 0.7	Add comment from R. Esposito, K. Clark, B. Bryant, C. Best, D. Fougne minor changes update to Hypergolic Maintenance Facility SOW add System Services Enhancement Thread update Hazardous Gas Interface update section 2 and 3	7/22/97
Draft 0.8	Place under control turn revision on	7/24/97
Draft 0.9	but 80k number on document	8/11/97
Draft 0.10	update per Strategic and DP1s add IPT and CSCI section split HMF Thread to System Capability Thread and HMF IPT. add Thread Signoff Sheets add Block Diagram, Software Diagram, Thread Drawing	10/1/97
Draft 0.11	Table Top Review	10/16/97
BASIC 1.0	Release	10/17/97
Basic 2.0	CCB to change desktop debug and put into CLCS template	

LIST OF EFFECTIVE PAGES

Dates of issue of change pages are:

[illegible]

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1. DELIVERY OVERVIEW:

The Thor Delivery is scheduled for completion on March 27, 1998. It is the third delivery of the CLCS Project. Thor consists of hardware, software, and facility products that will support the continuing CLCS development. Significant products deliveries will provide the foundation for the CLCS hardware and software architecture.

1.1 TOP LEVEL OVERVIEW

The Thor delivery focuses on providing support of End item Command and Control. This delivery will support full application development and set the ground work for the development of important system reliability and integrity features in the Atlas Delivery.:

The work in Thor divided into seven groups of deliverable types.

- **System Engineering Action** - The work required to support the next delivery in the major design areas. This is not all the work that is being performed in the System Design function of System Engineering & Integration just the major element to support the next delivery.
- **Facilities** - The sets of equipment and their content at the end of this delivery.
- **Hardware Products** - The hardware products that we will design and/or deliver during this delivery. They use the hardware development process and require reviews, approvals and buy-off.
- **Integrated Product Teams** - These are the application set development products. They use the application development process and require reviews, approvals and buy-off.
- **Pathfinders** - These are tasks to support activities in the next delivery. They are designed to find answers to design items in a less structured format. They are required to present a concept panel and status reports. They are under review regularly for redirection, termination or conversion to thread work.
- **Threads** - Thread are used to drive the development of system functions. They use the system software and hardware development process and require reviews, approvals and buy-off.
- **Delivery Action** -Delivery actions are used to track the progress of turn over of CLCS products to the operational world.

Major Events

The major events to occur during the Thor Delivery are:

1. Complete selection of production Command and Control Workstations, Support Workstations, Command and Control Processors, Data Distribution Processors, Gateway and Network hardware (6/1/87).
2. Release Revision 2 of the System Level Specification
3. Release Revision 1 of the Concept of Operations
4. Release the Thor System Design Document
5. Install Hardware at Hypergolic Maintenance Facility

System Capabilities

The significant capabilities provided by CLCS in this delivery are:

1. The capability to demonstrate Hypergolic Maintenance Facility Forward Reaction Control System applications.(6/1/97)
2. The full capability to interface with the Ground Data Bus.
3. The capability to interface with the Orbiter Downlink.
4. The capability to perform basic interface function with the Launch Data Bus.
5. The capability to demonstrate the Business and Information Network functions.
6. The capability to test application programs in the CLCS environment.
7. The capability to evaluate system performance in the CLCS environment.
8. The capability to provide increased command activity including CORBA application commanding.
9. The capability to receive consolidated data from METRO, GMS, IVHM, and Fuel Cell Monitor systems.
10. The capability to perform initial record and retrieval operations with the Shuttle Data Center

Deliveries Summary

- 7 RTPS Sets
- 2 Shuttle Data Center Sets
- ? System Engineering Actions.
- 6 Pathfinders
- 3 Integrated Product Teams
- 2 Integration Focal Threads
- 5 Gateway Threads
- 5 Foundation Threads
- 4 Application Software Threads
- 4 Application Support Threads
- 2 System Support Threads
- 2 Delivery and Activation Threads
- Associated CSCI Products, HWCI products, facility products and the support products discussed further in this document.

Figure 1 provides a high level map of the interrelationship of the various delivery elements that make up this delivery. The details of this map are in the Thor Delivery Map.

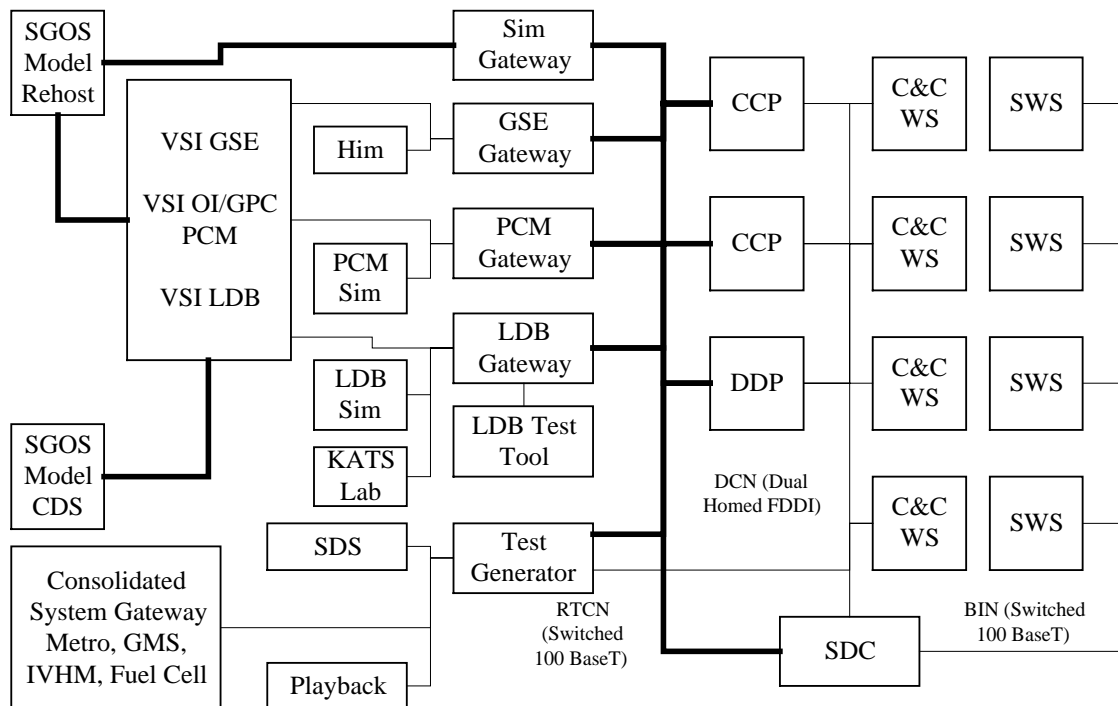


Figure 2 provides a high hardware level block diagram of the Thor system. The details of this block diagram are in the THOR set drawings for the Integrated Development Environment, Satellite Development Environment-1, Satellite Development Environment-2 and Hypergolic Maintenance Facility.

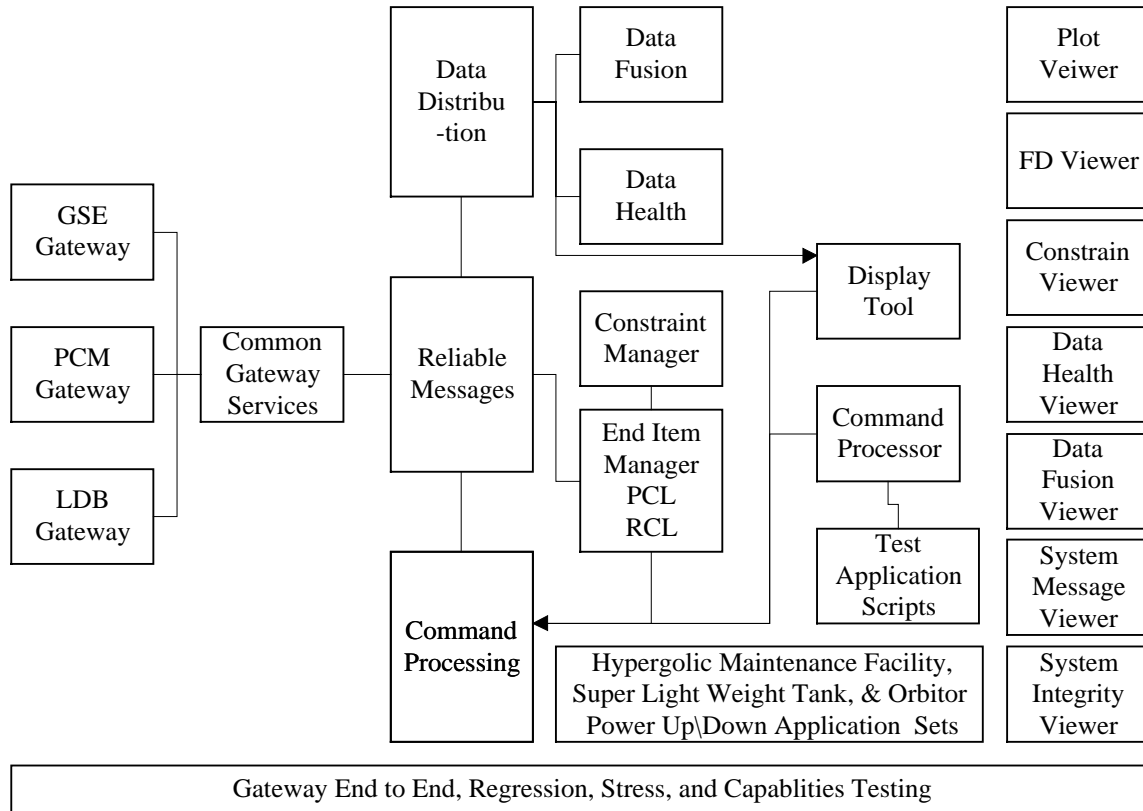


Figure 3 provides a high level diagram of the RTPS software for the Thor delivery

1.2 DELIVERABLE SUMMARY

System Engineering Action

- Provide study and recommendation on use of NT/Widows 95 for Command and Control Workstation
- Develop design for Redundancy Management
- Release revision 2 of the System Level Specification
- Release Revision 1 of the Concept of Operations
- Release the Thor System Design Document

Facilities

- LCC-X
- Operational Control Room 1-LCC
- Operational Control Room-Hypergolic Maintenance Facility
- Integrated Development Environment-1-LCC
- Satellite Development Environment--JSC
- Satellite Development Environment-1-PCC
- Satellite Development Environment-2-PCC
- Serial 0 Shuttle Data Center
- Shuttle Data Center Production Set 1
- Development Environment Products

Pathfinders

- **Gateway Open System Pathfinder** - The purpose of this pathfinder is to evaluate alternatives for gateway hardware. It is not the intent of this pathfinder to provide an extensive evaluation of alternatives but to collect data on alternatives if required in the future.
- **Command and Control Workstation/Command and Control Processor/Data Distribution Processor Open System Pathfinder** - The purpose of this pathfinder is to support evaluate of software portability.
- **Business and Information Network Pathfinder** - The purpose of this pathfinder is to demonstrate, in the Hypergolic Maintenance Facility environment, in an Office Environment and in an Operational Control Room environment (LCC-X) accessibility and connectivity to functions and services that are beneficial to processing.
- **Performance Modeling** - The purpose of this pathfinder is to capture the CLCS design in an accurate set of performance models. These models will be used as design aids, a means of demonstrating that the system successfully meets performance requirements, a trouble shooting environment.
- **Regression Testing Phase 1 Pathfinder** - The purpose of this pathfinder is to establish regression testing, procedure, tools and database as part of the CLCS project.

- **Test Application Scripts Pathfinder** - The purpose of this pathfinder is to provide the initial script function design.
- **Advanced Applications Pathfinder** - This Pathfinder is responsible for exploring the capabilities of advanced software technologies. Prototype software will be developed to demonstrate new technologies such as 3D visualization, virtual reality, and expert systems using Shuttle and aerospace applications

Integrated Product Teams

- **Hypergolic Maintenance Facility IPT** - This IPT will design and implement the Hypergolic Maintenance Facility Application Software. It is an early CLCS delivery into an operational environment.
- **Super Light Weight Tank IPT** - This IPT provides Monitor Application Software that demonstrates the capability of the CLCS System and User Display Applications to monitor the Super Light Weight Tank testing.
- **Orbiter Power Up/Down IPT** - This IPT will develop an Application software suite to support the automated power up/down of the Space Shuttle. The suite includes the auto power up/down sequence which is required by the Test Project Engineer (TPE), and the supporting subsystem software for the: Data Processing System (DPS), Environmental Control and Life Support System (ECLSS), Electrical Power and Distribution System (EPDC), Instrumentation System (INST), and test set master function (MSTR).

Threads

- **System Capability Thread** - This thread will demonstrate that we are ready to proceed with implementation and deployment of application software.
- **System Stress Test Thread** - This thread will evaluate if the CLCS architecture will be able to support system load conditions.
- **End to End Gateway Data Demonstration Thread** - This thread will demonstrate the ability to collect data from all CCMS link types
- **Ground Support Equipment and Common Gateway Completion Thread** - This thread provides a fully functional Ground Support Equipment Gateway
- **PCM Support Thread** - This thread establishes the initial capability to monitor PCM link FDs
- **Launch Data Bus Interface Phase 1 Thread** - This thread establishes the initial capability to monitor and command the Launch Data Bus
- **LIVIS/CWLIS, IVHM, Fuel Cell Monitor and other Consolidated Data Thread** - This thread provides process improvement to the current operations by providing increased visibility to the Lightning Detection System, Fuel Cell Monitor System, and Integrated Vehicle Health Monitoring System
- **Commanding and Command Processor Phase 2 Thread** - This thread supports commanding by cursor control, manual input, for Test Application Scripts and End item Managers. It also includes integration of CORBA into CLCS.
- **Data Distribution Completion Thread** - This thread provides the completion of support for end-to-end data flow of FDs
- **Reliable Messages Completion Thread** - This thread provides the completion of the reliable delivery network capability

- **System Integrity and Subsystem Initialization Phase 1 Thread** - This thread provides the supporting Subsystem Integrity infrastructure as a foundation for implementing System Integrity in Atlas
- **System Viewers Thread** - This thread provides the method and display for operators to understand the system without writing application code. This delivery updated Redstone viewer and provide new viewers for Constraint Management, End Item Managers and Subsystem Integrity
- **End Item Manager, Prerequisite Control Logic and Application Interface Thread** - This thread establishes the CLCS capability to provide process control, GOAL replacement to the RTPS system.
- **Simulation Gateway Phase 2 Thread** - This thread supports connection of the SGOS models to the CLCS RTCN and the Application Desktop Debug without the use of the front end gateways or Video Simulation Interface equipment.
- **Near Real-time Advisory Thread** - This thread supports advisory system capabilities for the CLCS Support Workstation and the Office Environment
- **Advanced Data Support Tools Thread** - This thread supports historical data retrieval and analysis similar to but improved upon what would be found on the CDS HI-TRAX system today.
- **Constraint Manager Phase 1 Thread** - This thread provides the initial Constraint Management Tool. Constraint Management provides the capability to monitor Measurement FDs for a predetermined condition and notify personnel operating the Test Set and software applications executing within the Test Set that the monitored data no longer meets the predetermined condition.
- **Data Health Completion Thread** - This thread provides the completion of the CLCS capability to provide health information for FDs.
- **Data Fusion Completion Thread** - This thread provides the completion of the CLCS capability to provide information using multiple FDs to produce a new FD. (Data Fusion).
- **Log Record and Retrieval Phase 1 Thread** - This thread establishes the frame work for CLCS data recording/retrieval, and to begin the migration of the retrieval process from the CCMS PDR/SPA and CDS/Shuttle Data Center to the CLCS system.
- **System Services Enhancement Thread** - This thread provides an enhancement to the system services provided in the Redstone Delivery and adds new services required for completion of the Thor Foundation Service, Application Support, and Application Software threads.

Operational Deliveries

- **Consolidated Shuttle Data Stream Gateway turnover** - This delivery is to complete the release of the Consolidated Shuttle Data Stream Gateway,
- **Shuttle Data Center-CDS Re-platform** - This delivery is to provide initial use for the Shuttle Data Center as a replacement for CDS,

1.3 APPROVAL PROCESS

Thor Working Baseline Review Copy 6/30/97

Project Management, Users, System Engineering
Scope Approval

Thor Working Baseline

System Engineering, CSCI/CSC,
Users, work toward DP1s

DP1s

Update to details of SOW but not scope
Thread Leads and System Engineering & Integration Signoff of DP1 Updates

Thor Baseline 9/15/97

Project Management, Users, System Engineering
Approval 10/1/97

Performing Organizations Sign Off 10/15/97

2. FACILITIES -- CONTROL ROOMS AND DEVELOPMENT ENVIRONMENTS

This is a list of the hardware in the facilities for CLCS. Note this is the state for all hardware at the end of this delivery after purchase of new equipment, use of existing equipment and moving of equipment from one set to another.

2.1 OPERATIONAL CONTROL ROOM 1—LCC

Product Overview:

Provide a Satellite Development Environment at the LCC for System Software and Application Software Development

Products:

- Decommission LCC4
- Provide requirement for OCR -1

HWCIIs

- None

2.2 OPERATIONAL CONTROL ROOM- HYPERGOLIC MAINTENANCE FACILITY

Product Overview:

Provide a Satellite Development Environment at the Hypergolic Maintenance Facility for System Software and Application Software Development

Facilities

- M7-1061 Option 1 Facility Prepared For Development Activity during Thor Delivery Time frame

HWCIIs

Quantity	Part Number	Product Type
1	Baynetwork 350t	100baseT Switch RTCN HWCI
2	Baynetwork FDDI 2914-04	Concentrator DCN HWCI
5	SGI O2	HCI Dev w/s HWCIIs
1	SGI Origin 2000	Data Distribution Processor HWCI
1	SGI Origin 2000	Command and Control Processor HWCI
1	SGI Origin 2000	DDP/CCP Spare
1	TBP	Black/White Laser Printers
1	TBP	Color Laser Printer
5	TBP	Single Position Console Enclosures
2	TBP	Console Support Modules
1	Sun Ultrasparc W/S	Gateway Development W/S
1	TBP	Network Time Server
7	TBP	SUPPORT Workstations
1	TBP	Network Server
1	TBP	Network Management Workstation
1	TBP	RON Network Server
1	SGI O2	CM/Boot Server
1	TBP	Local OMI Server
1	TBP	RTPS Firewall
2	TBP	BIN 10/100baseT Switch

Gateway HWCIIs

Quantity	Part Number	Product Type
4	TBD	CLCS Ground Support Equipment Gateway
1	TBD	Simulation Gateway

2.3 INTEGRATED DEVELOPMENT ENVIRONMENT-1-LCC

Product Overview:

Augment the existing Development Environment for System Software and Application Software Integrated Testing and Operational Deployment Preparation

Facilities

- LCC Room 2R23/24 Prepped for integrated system level testing Including:
 - Communications Consumables
 - Gateway Data Links
 - Simulation Data Links
 - Connectivity to LCC-X HCI

HWCI's

Quantity	Part Number	Product Type
1	Baynetwork 350t	100baseT Switch RTCN HWCI
2	Baynetwork FDDI 2914-04	Concentrator DCN HWCI
10	SGI O2	HCI Dev w/s HWCI's
1	SGI Origin 2000	Data Distribution Processor HWCI
1	SGI Origin 2000	Command and Control Processor HWCI
1	SGI Origin 2000	Command and Control Processor Data Distribution Processor spare
2	TBP	Black/White Laser Printers
1	TBP	Color Laser Printer
1	TBP	Network Time Server
2	TBP	SUPPORT Workstations
1	TBP	Network Server
1	TBP	RON Network Server
1	TBP	Network Management Workstation
1	SGI O2	CM/Boot Server
1	Sun Ultrasparc W/S	Gateway Development W/S
1	TBP	Local OMI Server
1	TBP	RTPS Firewall
2	TBP	BIN 10/100baseT Switch

Gateway HWCI's

Quantity	Part Number	Product Type
1	TBD	CLCS GSE Gateway
1	TBD	CLCS Cons. System Gateway
1	TBD	CLCS PCM D/L Gateway
1	TBD	CLCS LDB Gateway

2.4 SATELLITE DEVELOPMENT ENVIRONMENT-JSC

Product Overview:

Augment the existing Satellite Development Environment at JSC/LMSMSS for System Software and Application Software Development

HWCI Products:

<u>Quantity</u>	<u>Part Number</u>	<u>Product Type</u>
1	3Com Super Stack 3000	100baseT Switch RTCN HWCI
2	Baynetwork FDDI 2914-04	Concentrator DCN HWCI
12	SGI O2	HCI Dev w/s HWCI's
1	SGI Origin 2000	Data Distribution Processor HWCI
1	SGI Origin 2000	Command and Control Processor HWCI
1	TBP	Black/White Laser Printer
1	3Com LANplex 2500	Edge Device - ATM to Ethernet
1	SGI O2	Support Server

Gateway HWCI's

<u>Quantity</u>	<u>Part Number</u>	<u>Product Type</u>
1	TBD	CLCS Cons. System Gateway

2.5 SATELLITE DEVELOPMENT ENVIRNOMENT-1-PCC

Product Overview:

Augment the existing hardware in the Satellite Development Envirnoment-1-PCC to support hardware, system software and application development in either a redundant or dual string configuration.

HWCI Products:

Quantity	Part Number	Product Type
1	3Com Super Stack 3000	100baseT Switch RTCN HWCI
2	Baynetwork FDDI 2914-04	Concentrator DCN HWCI
6	SGI - O2/Indigo	HCI Dev w/s HWCIs
1	SGI Origin 2000	Data Distribution Processor HWCI
1	SGI Origin 2000	Command and Control Processor HWCI
1	SGI Origin 2000	CCP/DDP Spare
2	TBP	Black/White Laser Printers
1	TBP	Color Laser Printer
1	TBP	Network Time Server
2	TBP	SUPPORT Workstations
1	TBP	Network Server
1	TBP	Network Management Workstation
1	TBP	RON Network Server
1	SGI O2	CM/Boot Server
1	TBP	Local OMI Server

Gateway HWCIs

Quantity	Part Number	Product Type
2	TBD	CLCS GSE Gateway
1	TBD	CLCS Cons. System Gateway
1	TBD	CLCS PCM D/L Gateway
1	TBD	CLCS LDB Gateway

2.6 SATELLITE DEVELOPMENT ENVIRNOMENT-2-PCC

Product Overview:

Augmentation of existing hardware in the Satellite Development Envirnoment-2-PCC to support hardware, system software, and application development in a single string with redundancy or dual string with no redundancy

HWCI's Products:

<u>Quantity</u>	<u>Part Number</u>	<u>Product Type</u>
1	Baynetwork 350t	100baseT Switch RTCN HWCI
2	Baynetwork FDDI 2914-04	Concentrator DCN HWCI
6	SGI O2/Indigo	HCI Dev w/s HWCI's
1	SGI Origin 2000	Data Distribution Processor HWCI
1	SGI Origin 2000	Command and Control Processor HWCI
1	SGI Origin 2000	CCP/DDP Spare
2	TBP	Black/White Laser Printers
1	TBP	Color Laser Printer
1	TBP	Network Time Server
2	TBP	SUPPORT Workstations
1	TBP	Network Server
1	TBP	Network Management Workstation
1	TBP	RON Network Server
1	SGI O2	CM/Boot Server
1	TBP	Local OMI Server

Gateway HWCI's

<u>Quantity</u>	<u>Part Number</u>	<u>Product Type</u>
2	TBD	CLCS GSE Gateway
1	TBD	CLCS Cons. System Gateway
2	TBD	CLCS PCM D/L Gateway
1	TBD	CLCS LDB Gateway

2.7 LCC-X

Product Overview:

Upgrades to the LCC-X Demonstration Center in LCC 2 to support user interface and feedback.

HWCI's Products:

Quantity	Part Number	Product Type
1	3Com Super Stack 3000	100baseT Switch RTCN HWCI
4	Baynetwork FDDI 2914-04	Concentrator DCN HWCI
1	SGI Origin 2000	Data Distribution Processor HWCI
1	SGI Origin 2000	Command and Control Processor HWCI
3	SGI - O2/Indigo	HCI Dev w/s HWCI's
2	TBP	Support Workstation
1	TBP	Color Printer
1	TBP	Black and White Printer
2	TBP	BIN 10/100baseT Switch

Prototype Console Enclosure (Delivered to LCC-X)

- Acquisition Strategy and Vender Selection(s) For Console Enclosure
- Platform Workstation Decision
- Flat Panels vs CRT Decision
- Command Panel Decision (Virtual PFP vs Dedicated H/W)

Quantity	Part Number	Product Type
3		First Article Console Enclosure
2		Prototype Command Panel (Programmable Function Panel Replacement)
1		Prototype Safing Panel Concept
2		First Article Support Module
2		Preliminary OTV Integration Module (TBD)
1		Prototype Power distribution Chassis

Gateway HWCI's

Quantity	Part Number	Product Type
1	TBD	CLCS GSE Gateway
1	TBD	CLCS Cons. System Gateway

2.8 SHUTTLE DATA CENTER-SERIAL 0

Product Overview:

Shuttle Data Center Serial 0 is a validation set installed to allow testing of full system software on a minimal configuration system.

HWCI's Products:

<u>Quantity</u>	<u>Part Number</u>	<u>Product Type</u>
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2.9 SHUTTLE DATA CENTER-PRODUCTION SET 1

Product Overview:

Shuttle Data Center Production Set 1 is a full up production set to perform initial operational support and user validation of the Shuttle Data Center software set.

HWCI's Products:

<u>Quantity</u>	<u>Part Number</u>	<u>Product Type</u>
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2.10 DEVELOPMENT ENVIRONMENT PRODUCTS

These products will be shared and distributed to the various Satellite Development Environments as indicated by requirements capture.

Quantity	Part Name/No.	Product Type
95	SIG 02	Development Workstation
1	Auspex Server	Upgrade Development Environment Server for PCC
As Required	TBP	Communication Consumables: Fiber, Cable
As Required	TBP	Developer Support Items: Chairs, Desks

3. SYSTEM ENGINEERING ACTION

- Provide study and recommendation on use of NT/Windows 95 for Command and Control Workstation
- Develop design for Redundancy Management
- Release revision 2 of the System Level Specification
- Release Revision 1 of the Concept of Operations
- Release Draft of the System Design Document

4. PATHFINDERS

4.1 OPEN SYSTEM PATHFINDER

4.1.1 Gateway Open System Pathfinder

Overview:

The purpose of this pathfinder is to evaluate alternatives for gateway hardware. It is not the intent of this pathfinder to provide an extensive evaluation of alternatives but to collect data on alternatives if required in the future.

Statement of Work:

- Provide a list of vendors and limited evaluation of VME board using selected CPU chip.
- Order board from at least one alternative source and confirm that software could be ported. The port will not have to be a complete port of all code.
- Provide a list of and limited evaluation of VME boards using other CPU chips that provide the required performance for the gateway job. This should include but not be limited to support of required COTS software and device support.
- Provide a list of vendors and limited evaluation for other boards in the system.

4.1.2 Command and Control Workstation/Command and Control Processor/Data Distribution Processor Open System Pathfinder

Overview:

The purpose of this pathfinder is to support evaluate of software portability. It will collect alternatives for Command and Control Workstation/Data Distribution Processor/Command and Control Processor hardware and software. It is not the intent of this pathfinder to provide an extensive evaluation of alternatives but to collect data on alternatives if required in the future. This will help us to establish a hardware baseline for the system.

Statement of Work:

- Provide a list of and limited evaluation of CPUs for the Command and Control Workstations. This should include but not be limited to support of required COTS software, cost, and porting issues.
- Provide a list of and limited evaluation of UNIX CPUs for the Command and Control Processor/Data Distribution Processor job. This should include but not be limited to support of required COTS software, cost, and porting issues.
- Perform a port to another vendor (DEC, HP, or SUN) 2 months after the Thor delivery (6/1/97)

4.2 BUSINESS AND INFORMATION NETWORK PATHFINDER

Overview:

The purpose of this pathfinder is to demonstrate, in the Hypergolic Maintenance Facility environment, in an Office Environment and in an Operational Control Room environment (LCC-X) accessibility and connectivity to functions and services that are beneficial to processing. These functions and services may execute within the CLCS or on a remote system.

Highlights:

- Demonstrate capability on Hypergolic Maintenance Facility workstations
- Demonstrate capability on LCC-X workstations
- Demonstrate CCMS data retrievals from the Shuttle Data Center
- Demonstrate capability on both UNIX and NT workstations
- Demonstrate access to Office Products executing on a server
- Demonstrate access to SPDMS applications
- Demonstrate access to selected advisory systems
- Demonstrate access to selected documentation and drawing sources
- Demonstrate monitoring of selected data displays
- Demonstrate Command and Control Workstation like function on the office environment
-

Statement of Work:

- Identify and acquire access to Hypergolic Maintenance Facility workstations and external systems to be used in the pathfinder
- Identify and acquire access to LCC-X workstations and external systems to be used in the pathfinder
- Identify and acquire access to office workstations and external systems to be used in the pathfinder
- Identify point of contact and system administrator for selected external systems
- Obtain userid and passwords for all external systems selected for the demos
- Verify network access and proper user permissions exist in order to perform required functions
- Identify and acquire all required Support Workstation Platform system and support software for all computer platforms selected for the demos
- Install system and support software on all computers to be used in the demos
- Develop Web pages to support prototype testing and demos
- Develop required shell scripts
- Perform functional tests of selected external systems and services to be used in the demos

- Provide demo user guides
- Support Hypergolic Maintenance Facility users in familiarization and use of the BASIS
- Support LCC-X users in familiarization and use of the BASIS
- Develop design for Command and Control Workstation function outside the LCC.
 - Provide Application Service to support Command and Control Workstation functions on Support Workstation.
- Support Command and Control Workstation function outside of the LCC
 - Provide Command and Control Workstation User Display execution on Support Workstation
 - Provide basic FD Viewer
 - Provide System Message viewer
 - Provide DMON
 - Provide FD plotting
- Shuttle Data Stream
 - Define replacement Shuttle Data Stream for KSC and other centers
 - Provide data function for office

4.3 PERFORMANCE MODELING

Overview:

The purpose of this pathfinder is to capture the CLCS design in an accurate set of performance models. These models will be used as design aids, a means of demonstrating that the system successfully meets performance requirements, a trouble shooting environment.

Highlights:

- Capture the performance and architectural characteristics of each of the major components of CLCS.
- Analyze performance requirements and confirm that these are allocated to some portion of the system.
- Provide input to architectural trade studies by modeling configurations and identifying trouble spots as well as possible alternate designs.

Statement of Work:

- Develop a quantified list of performance requirements that can be mapped to components of the system.
- Concentrate on the most difficult questions of performance.
- Develop a model for the Data Distribution Processor and components of the RTPS/Shuttle Data Center interfaces.
- Identify measurements required to parameterize the model in such a way as to accurately characterize the system.
- Define real-time performance acquisition, monitoring, logging, and display in the system.
- Create models of both the measurement and command workloads.
- Validate Data Distribution Processor and RTPS/Shuttle Data Center interface models through use of workload models to drive both simulation and measurements of system performance.
- Prioritize Data Distribution Processor evaluation to support Hardware Design Review, and identify if platform or Operating System changes are required
- Present results and point out any significant problem areas.
- Develop "level 3" models of the system including the Gateways, the Command and Control Workstations, and the Command and Control Processors, as well as selected applications being developed for the Hypergolic Maintenance Facility to identify other areas of concern.

4.4 REGRESSION TESTING PHASE 1 PATHFINDER

Overview:

The purpose of this pathfinder is to establish regression testing, procedure, tools and database as part of the CLCS project.

Statement of Work:

- Provide an initial set of, and selection/procurement recommendation for, Regression Test tools for testing system and applications software.
- Integrate Regression Test definitions and test results in the CM Repository.
- Demonstrate test support for the following:
 - Component level regression testing (system software)
 - Major API and COTS package regression testing(system software)
 - System Level end to end regression testing.(system/user software)
 - Automated end to end functionality via software calls and graphical user interfaces(system/user software)

4.5 TEST APPLICATION SCRIPTS PATHFINDER

Overview:

The purpose of this pathfinder is to provide the initial script function design. The Test Application Script function provides a capability to define a sequence of events required for a given test. Test Application Scripts are implemented in a manner that is clearly understandable and usable by system engineering and test management personnel and analogous to printed test procedures.

Highlights:

- Develop Test Application Script Editor design and demo.
- Test Application Script Viewer demo

Statement Of Work

- Define Test Application Script function required for CLCS considering these factors:
 - Capability of issuing commands to End-Item Managers.
 - Capability of issuing FD Commands.
 - Capability of reading, testing, and displaying FDs.
 - Capability of initiating other Test Application Scripts.
 - Capability to accept direct engineering input to confirm completion of manual operations.
 - Capability to monitor Test Application Script progress with a viewer.
 - Capability to hold, run, step, and breakpoint for execution control.
 - Capability to print completion status of each script step to a file to document script execution.
- Determine if a COTS tool or re-use code can be utilized.

4.6 ADVANCED APPLICATIONS PATHFINDER

Overview:

This Pathfinder is responsible for exploring the capabilities of advanced software technologies. Prototype software will be developed to demonstrate new technologies such as 3D visualization, virtual reality, and expert systems using Shuttle and aerospace applications. This software is intended to show the capabilities and possibilities of cutting edge technologies. The software will not be formally validated. This effort will continue after Thor.

Highlights:

- Expand on the Shuttle launch model that was developed during Redstone.
- Explore the use of OTV display and control capability.
- Explore the use of a Launch Commit Criteria monitor and notification capability.

Statement Of Work

- Expand on the Shuttle launch model that was developed during Redstone to:
 - Access the CLCS Data Stream
 - Incorporate SLWT strain gauges
 - Include additional facilities such as the VAB and Shuttle Landing Strip
 - Explore the incorporation of an X-34 model
- Explore the use of OTV display and control capability
- Explore the use of a Launch Commit Criteria monitor and notification capability

5. INTEGRATED PRODUCT TEAMS

The integrated Product Team for Thor are:

- Hypergolic Maintenance Facility IPT
- Super Light Weight Tank IPT
- Orbiter Power Up Down IPT

5.1 HYPERGOLIC MAINTENANCE FACILITY IPT.

Overview:

This Integrated Product Team (IPT) is responsible for the definition, design, and development of the Hypergolic Maintenance Facility (HMF) Real-time Control Application Software. This includes software to support the check-out and maintenance testing of the Forward Reaction Control System and Aft Propulsion System. The completion of this IPT's software development will be in the post-Thor timeframe. The following Highlights and Statement of Work apply only to those items which will be worked for Thor.

Highlights:

- Continue development of Forward Reaction Control System application software
- Begin development of an Aft Propulsion System application software

Statement Of Work

- Continue development of Forward Reaction Control System application software (development was initiated as part of the Hypergolic Maintenance Facility Pathfinder Thread during the Redstone period)
 - Finalize Forward Reaction Control System Functional Requirements Document
 - Generate the Forward Reaction Control System sections of the Hypergolic Maintenance Facility Software Design Specification
 - Develop the Command and Control Workstation Display Manager and Command and Control Processor Manager programs
 - Complete Forward Reaction Control System Displays development
 - Continue design and development of Forward Reaction Control System End Item Managers (EIM's)
 - Integrate EIM's and Displays with Application Services for inter-process communications
- Begin development of an Aft Propulsion System Functional Requirements Document

5.2 SUPER LIGHT WEIGHT TANK IPT

Overview:

This IPT provides Monitor Application Software that demonstrates the capability of the CLCS System (from Gateway to Command and Control Workstation) and User Display Applications to monitor the Super Light Weight Tank testing. The major system functions demonstrated will be the Consolidated Systems Gateway (with SDS, GMS & Metro Measurements), Data Fusion, Data Health, Data Distribution and the Dynamic Display Visualization Tool

Highlights:

- Application Software set will be used to support Tanking Test.

Statement Of Work

- Provide support for Tanking Test.
- Update display as required for Tanking Test

5.3 ORBITER POWER UP DOWN IPT

Overview:

This Integrated Product Team (IPT) is responsible for the definition, design, and development of the Real-Time Control Application software suite to support the automated power up/down of the Space Shuttle. The suite includes the auto power up/down sequence which is required by the Test Project Engineer (TPE), and the supporting subsystem software for the: Data Processing System (DPS), Environmental Control and Life Support System (ECLSS), Electrical Power and Distribution System (EPDC), Instrumentation System (INST) and test set master function (MSTR). The Applications suite not only includes power up/down sequence functionality, but the components required by these systems to monitor GSE and Flight Hardware when that hardware is active. The active monitor function is referred to as "Baby-sit". Baby-sit is a Space Shuttle Vehicle capability that allows Shuttle checkout and test. The completion of this IPT's software development will be in the post-Thor time-frame (scheduled completion is Titan). The following Highlights and Statement of Work apply only to those items which will be worked for Thor.

Highlights:

- Develop the Functional Requirements documents to support Automated Power Up/Down and the "Baby-sit" monitor function.
- Begin Power Up/Down Real-Time Control Application software design

Statement Of Work

- Generate the Power Up/Down and "Baby-sit" support section of the Functional Requirements Documents for the following Applications:
 - Integrated Operations (does not complete all IntgOps requirements)
 - DPS (does not complete all DPS requirements)
 - ECLSS (does not complete all ECLSS requirements)
 - EPDC (does not complete all EPDC requirements)
 - INS (does not complete all INS requirements)
 - MASTER (does not complete all MASTER requirements)
- Begin to populate the Common Application Support Functional Requirements Document with multiply referenced requirements (locate requirement once in a standard repository).
- Begin design of power Up/Down and Baby-sit Real-Time Control application software
 - Begin design/development of Auto Power Up/Down Displays
 - Begin End Item Components/Managers (EIMs/EICs) design

6. THOR THREADS

Note: The inclusion of the SLS performance requirements are to document those performance requirements that must be met for this delivery. As part of Design Panel 1 and Design Panel 2 a more complete list of requirements effecting the thread are developed.

6.1 DELIVERY LEVEL INTEGRATION DEMONSTRATION THREAD GROUP

The Delivery Level Integration Demonstration Threads are:

- System Capability Demonstration Focus Thread
- System Stress Test Project Focus Thread

6.1.1 System Capability Demonstration Thread.

Overview:

This thread will demonstrate that we are ready to proceed with implementation and deployment of application software. This demonstration will show the aggregate delivered capabilities (through the Thor Delivery) of the CLCS. Real Time Control (RTC) Applications Software (non-validated) will be used to confirm the CLCS command, control and monitoring concepts are solid and that the support infrastructure is ready to support future RTC Applications Software development. Capabilities not directly related to RTC Applications Software will be demonstrated using viewers and other applications developed for those CSCIs (e.g., SDC data retrieval applications).

Highlights:

- Provide a demonstration of Application software running with SGOS Models on the Central Data System (CDS) thru the Video Simulation Interface.(Gateway & Foundation)
- Provide a demonstration of Application software running with SGOS Models on the Simulation Re-platform Host thru the Simulation Gateway.(Support Thread)
- Provide a demonstration of Application software running with SGOS Models on the Simulation Re-platform Host thru the Video Simulation Interface. (Support Thread)
- Provide a demonstration of data retrieval and analysis from the Shuttle Data Center.(Support Thread)

Assumptions

The following assumptions are made to preclude additional project costs just to produce a demonstration product:

- The demonstration will take place two to three months post Thor delivery to provide sufficient time for inclusion of system capabilities delivered in Thor to be implemented in Application Software.
- Demonstration parameters will be based only on Application Software that is scheduled for a normal delivery. Specific application software development work will not be performed merely to support the demonstration.
- Validated Applications Software is not required for the demonstration. Applications Software support provides a mechanism to demonstrate system capabilities.

Statement Of Work

- Demonstrate all aspects of Application Software's use of the system capabilities to provide vehicle/GSE checkout functions. An SGOS simulation math model (via the simulation gateway, VSI or other connection) will be used to provide "end item destinations".
 - Command and Control Workstation and End Item Manager command communications
 - End Item Manager to End Item Manager command communications
 - Command Processor to End Item Manager command communication.
 - Command Processor to FD command communication.
 - Command and Control Workstation and End Item Manager command authentication
 - Automated sequence command communications

- Derived/Fused FD addition to the Data Distribution stream
- Setting/Responding to Application Software asserted constraints
- Prerequisite Control Logic performance
- Reactive Control Logic performance
- Logging, Recording and Retrieval of CLCS measurements, command, messages and packets.
- Demonstrate capabilities for data retrieval and analysis from the Shuttle Data Center (Support Workstation Thor Command and Control Workstation Atlas)
- Demonstrate capabilities of all available System Viewers:
 - Data Health Viewer
 - Data Fusion Viewer
 - Constraint Viewer
 - Subsystem Health Viewer
 - System Message Viewer
 - Subsystem Integrity Viewer
- Demonstrate PCM downlink interface and LDB capabilities. This will be performed using the user interface developed in support of these gateway threads. No Application Software use of these capabilities will be demonstrated
- Demonstrate Display support for the following consolidated data systems:
 - METRO
 - Fuel Cell
 - *LIVIS/CWLIS (Atlas)*
 - Integrated Vehicle Health Management
 - GMS
- Definition of data fusion using the FD Creation Tool

6.1.2 System Stress Test Thread

Overview:

This thread will evaluate if the CLCS architecture will be able to support system load conditions. This has been provided as a thread to coordinate work required to provide this test case.

Highlights:

- Demonstration of the system under several load conditions. (Support Thread)
- Establish System Stress Test

Statement Of Work

- Develop and present a long term Stress Test top level design for Thor
- Perform Test with Thor Baseline.
- Simulate, using real, Simulation or Test Gateway, 5 Ground Support Equipment bus, 1 PCM Link, and 3 Space Shuttle Main Engine links running at rates up to all data changing.
- Utilize between 100-200 Test measurement FDs
- Provide a group of simple Data Fusion functions for up to 50% of the Test measurement FDs
 - AND two Digital Patterns.
 - Average two Analogs
 - Time average Analog
 - Peak Detection
 - Compare an Analog
 - Vote three Discretes
- Provide a group of simple End Item Managers, up to 30 per Command and Control Processor
 - Provide 10 End Item Managers that read 60 values every 100 ms. (600 FD reads)
 - Provide 4 End Item Managers that read all changes of a value and signal with an event 4 other End Item Managers when value transitions a limit, 10 times per second. (160 events)
 - Provide 13 End Item Managers that react to events from other End Item Managers and output a Pseudo FD Measurement.(160 FD writes)
 - Provide 1 End Item Managers that sends Commands to Ground Support Equipment at up to max rate. (500 commands)
 - Provide 1 End Item Managers that sends system messages at rate of 0.1 to 20 per second.
 - Provide 1 End Item Managers that continues execution of based on an event from Constraint Management
- Run the Hypergolic Maintenance Facility Forward Reaction Control System End Item Manager

- Run up to 10 Dynamic including Hypergolic Maintenance Facility Forward Reaction Control System displays in a Command and Control Workstation.
- Provide performance data for system modeling.
- Provide a mechanism to increase load beyond the performance requirements.

Performance Requirement from SLS

- The system shall support 25,000 End-Item Function Designator changes per second continuously. This is the “system maximum data bandwidth”.
- The system shall support a peak of 50,000 End-Item Function Designator changes in a given second without losing any data
- RTPS shall be able to support full Uplink command rates on the following links:
 - Ground Support Equipment - 500/second.
- The Data Health Function shall support the “system maximum data bandwidth”.
- The Data Fusion function shall support the “system maximum data bandwidth” with one fusion calculation per End-Item Function Designator change.
- The Display function shall, for a single workstation, support updating 50% of the FDs every second on 13 windows with 100 FDs in each window
- Each Command and Control Processor shall support 5 End-Item System test applications, with 6 test applications for each System (30 Processes) with each test application executing 500 Application Service calls per second (15,000 calls/second) while executing at 5 percent of the system maximum data bandwidth (TBD). The ratio of application service calls are 45 local application services (read, if, compare, etc.), 4 constraint management notification changes and 1 command for every 50 calls. The test applications are to be the same priority level and each is allowed to execute at least 10 times per second.

6.2 GATEWAY INTERFACES THREAD GROUP

The Gateway Interface Threads are:

- End to End Gateway Data Demonstration Thread
- Ground Support Equipment and Common Gateway Completion Thread
- PCM Interface Thread
- Launch Data Bus Interface Phase 1 Thread
- LIVIS/CWLIS, IVHM, Fuel Cell Monitor and other Consolidated Data Thread

6.2.1 End to End Gateway Data Demonstration Thread

Overview:

This thread will demonstrate the ability to collect data from all CCMS link types. The purpose of this thread is to lay the foundation for Orbiter power up in Atlas.

Highlights:

- Produce the equivalent data stream produced by the Consolidated System Gateway using real Gateways.
- Provide displays for all data types on all links.
- Demonstrate data collection and transfer from the Video Simulation Interface thru the Gateways, Data Distribution Processor and Command and Control Workstation for those displays.

Statement Of Work

- Demonstrate 1 Ground Support Equipment Links, 1 PCM link, 1 Space Shuttle Main Engine link, and limited Launch Data Bus.
- Demonstrate capability to change PCM formats.
- Demonstrate capability to change scan rate of Ground Support Equipment FDs
- Demonstrate capability for enabling and disabling processing on FDs.
- Demonstrate capability to process and distribute all samples of FDs.
- Demonstrate capability to change Calibration and Engineering Units Conversion of FDs.
- Provide a set of displays that display all data types for the links being demonstrated.
- Demonstrate these displays with the Consolidated System Gateway.
- Demonstrated these displays with the real gateway and Video Simulation Interface.

Performance Requirement from SLS

- Performance measurement demonstration

6.2.2 Ground Support Equipment and Common Gateway Completion Thread

Overview:

This thread provides a fully functional Ground Support Equipment Gateway. This is needed to allow deployment to the Hypergolic Maintenance Facility in the Atlas delivery. Addition will be needed later in the project to support system integrity, redundancy management, and special data handling. These will be covered in a redundancy thread.

Highlights:

- Bring the Ground Support Equipment Gateway to full operational status.
- Support all data types.
- Support changes in operational modes.

Statement Of Work

- Provide the application services required to support all Ground Support Equipment FDs.
- Add support for Table Maintenance Function.
- Add support for changing polling rates.
- Add support for enabling and disabling processing of selected FDs.
- Add support for enabling and disabling collection and distribution of all samples of selected FDs.
- Add support for modification of Calibration and Engineering Units of selected FDs.
- Add support for generation of Ground Support Equipment Gateway Status FDs.
- *Add support for checkpoint(Atlas for full support)*
- Add support for health packet and system integrity data.
- Build, load, distribute, and initialize all TCID table and SCID software required to support Ground Support Equipment operation.

Performance Requirement from SLS

- RTPS shall be able to support full Uplink command rates on the following links:
 - GSE - 500/second.
- All gateways shall be able to support full link bandwidth with all values changing every sample.
- All subsystems acquiring data from external Ground Support Equipment shall be synchronized to Range Time to within 10 microseconds to support 100 microsecond measurement time-stamping.

6.2.3 PCM Support Thread

Overview:

This thread establishes the initial capability to monitor PCM link FDs. Recording, Retrieval, Data Bank, application services, display services, Data Distribution, System Build services and Test Build services will support basic CCMS format PCM FDs.

The Space Shuttle Main Engine, Pulse Code Modulation (PCM) downlink interface consists of three separate one-way telemetry data streams from the Orbiter Main Engine Controllers (MEC) via the Engine Interface Units (EIU). This downlink is the primary method for the Space Shuttle Main Engine s to communicate measurements, health, and status to the ground system.

Highlights:

- Provide support for basic measurement types.
- Provide for table loads to support different link rates and formats.
- Provide basic gateway control functions.

Statement Of Work

- Provide support for 128 kbits OI/GPC ,and *Space Shuttle Main Engine 60 kbits links*.(SSME Atlas)
- Provide the Test Build Services capable of supporting the PCM FDs, including PCM Gateway Table Generation and On-Line Data Bank Generation.
- Provide a PCM Gateway capable of decom of a CCMS formatted PCM link and providing Change Data Packets via the RTCN at the system synchronous rate (5-50msec).
- Provide the capability to detect and report PCM Link Errors and update the FD Status appropriately.
- Provide the capability to load/reload the PCM Gateway Tables in the Gateway.
- Provide the initial capability to record and retrieve the PCM FDs via Shuttle Data Center .
- Provide the application services required to support display of PCM FDs.
- Define and support the PCM measurement FDs (AM, DM, DPM, 32 Bit GPC Floating Point, Support for 64 Bit GPC Floating Point).
- Provide support for enable and disable processing.
- Provide support for enabling and disabling collection and distribution of all samples of selected FDs.
- Provide support for modification of calibration and engineering units.
- Provide support for format changes
- *Provide support for super commutated Space Shuttle Main Engine FDs(Atlas*
- Provide a user display capability to display PCM Data Types
- Build, load, distribute, and initialize all TCID table and SCID software required to support PCM operation.

Performance Requirement from SLS

- All gateways shall be able to support full link bandwidth with all values changing every sample.
- All subsystems (except workstations and Ground Support Equipment Link Gateways) shall be synchronized to Range Time within TBD microseconds to support 1 millisecond time-stamping of measurements.

6.2.4 Launch Data Bus Interface Phase 1 Thread

Overview:

This thread establishes the initial capability to monitor and command the Launch Data Bus. The Launch Data Bus (Launch Data Bus) is the interface between the Orbiter data processing system and all applicable ground facilities for test, checkout, maintenance, preflight, and post-flight phases. In addition, this common software interface provides the RTPS with access to the devices that are attached to the Launch Data Bus when the General Purpose Computers (GPC) are not active on the Launch Data Bus.

Highlights:

- Basic Launch Data Bus function in SACS and TCS-1 mode.
- GPC Memory Reads
- GPC Memory Writes
- DEU Keystrokes

Statement Of Work

- A GPC simulator will be developed to provide simulated Launch Data Bus polling, accept Launch Data Bus data transmissions, and provide a limited set of simulated GPC responses. The GPC simulator will provide Launch Data Bus polling on either bus, provide bus switching, and provide limited error injection capabilities. The GPC simulator will be used to verify Launch Data Bus gateway bus communications in a standalone environment.
- A Launch Data Bus monitor will be developed to capture, time tag, and record all Launch Data Bus traffic on both buses. The Launch Data Bus monitor will be used to verify Launch Data Bus gateway bus communications in a standalone environment as well as at the KATS lab.
- A TCL shell based Command and Control Processor simulator and associated GUI will be developed to send simulated RTCN packets to and receive simulated RTCN packets from a Launch Data Bus Gateway via Ethernet.
- A single-string non-redundant Launch Data Bus Gateway prototype will be developed which will accept and queue commands from a Command and Control Processor simulator, transmit the commands to a GPC located in the KATS lab, receive responses from the GPC, and return the response to the Command and Control Processor simulator for display. Commands from and responses to the Command and Control Processor simulator will be sent via Ethernet utilizing RTCN payload formats.
- The following SACS and TCS-1 commands will be implemented:

Route Code	Request ID	150 OP Code	Operator	Description
11	1, 51-54	3	ISSUE	Issue Command to GPC (MDM only)
11	2	4	G-MEM Write	Write to GPC Memory
11	24	5	G-MEM Read	Read from GPC Memory
11	3	6	EQ DEU	Send Simulated Keystrokes to GPC
11	20	7	LDB CNTL	Control LDB Polling
11	42, 57-60	8	READ	Read Command from GPC (MDM only)

11	46	13	TEXT	Send DEU Text Messages to GPC
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- Basic Launch Data Bus Gateway tables will be defined and a Launch Data Bus Gateway initialization and table load process will be developed. Launch Data Bus Gateway hardware safing tables and initialization will not be developed for Thor.
- Capability to receive a Command and Control Processor generated Launch Data Bus command, transmit the command to the GPC simulator, receive a response from the GPC simulator, and return the response to the Command and Control Processor will be developed.
- Provide the capability to perform Launch Data Bus operations using command processing and command management from an application or command processor
- Provide the application services required to support display of Launch Data Bus data.
- Provide a user display capability to control Launch Data Bus functions
- Build, load, distribute, and initialize all TCID table and SCID software required to support Launch Data Bus operation.

Performance Requirement from SLS

- None assigned for Thor

6.2.5 LIVIS/CWLIS, IVHM, Fuel Cell Monitor and other Consolidated Data Thread

Overview:

This thread provides process improvement to the current operations by providing increased visibility to the Lightning Detection System, Fuel Cell Monitor System, and Integrated Vehicle Health Monitoring System. These measurements will be consolidated in to the Shuttle Data Stream. This will make this data available in the current operational area and allow it to be used in the future by the CLCS system.

The Integrated Vehicle Health Monitoring project is part of the Shuttle Upgrades program. Vehicle Health Monitoring Technology Demonstration, demonstrates two off-the-shelf sensing technologies in an operational environment to make informed design decisions for the eventual Orbiter upgrade VHM. Vehicle Health Monitoring takes the Orbiter's instrumentation system a step further by providing capabilities to process data real-time versus merely recording data. It is planned to fly two HEDS Technology Demonstrations on the same Orbiter on successive flights with incorporation of additional sensors between flights. During cryogenic propellant load in terminal launch countdown, a Vehicle Health Monitoring data stream will be routed out of the Orbiter's T-0 umbilical for transmission, processing and viewing in the Launch Control Center. At approximately T-5 minutes, a command will be sent to the Vehicle Health Monitoring processor to begin recording data. Data will be recorded on ascent, during three planned one hour snap shot periods and on descent. The processor will be dumped to a ground system after the Orbiter has landed and has rolled into its Orbiter Processing Facility bay.

The Catenary Wire Lightning Instrumentation System (CWLIS) senses any lightning currents in the wire and evaluates them to see what potential they may have for causing damage to sensitive electrical equipment. The CWLIS current sensors are located at each end of the Catenary Wire and detect and record lightning flashes to provide potential damage assessment data for the CWLIS.

The Lightning Induced Voltage Instrumentation System (LIVIS), detects and records any transient electrical charges that might exist in Space Shuttle electronic systems or on the vehicle's skin. This system is installed in the MLP and monitor conditions while the Shuttle is on the way to the launch pad via the crawlerway and at the pad itself. Two additional LIVIS sensors monitor the induced effects of any lightning activity in the Payload Changeout Room inside the Rotating Service Structure.

The Backup hazardous Gas Detection System consists of a set of specialized hardware and software located in each of the mobile launchers. The system provides LPS HIM's with a very minimal set of data. The system is controlled (and more detail data is displayed) via a dumb terminal ;located in the CCMS control rooms. There is a project to upgrade this interface with a PC-based GUI (Labview) for command and control. This interface will provide a Shuttle Data Stream Prime to provide this data to the user community.

Additional data sources will be added to the Consolidated System Gateway and for recording on Shuttle Data Center .

Highlights:

- Additional data available in the operational control rooms
 - Fuel Cell Monitor
 - *LIVIS/ CWLIS (Atlas)*
 - Integrated Vehicle Health Monitoring
- Start interface to these additional data sources:
 - Record Playback System
 - Hazardous Gas
 - Engine Shop

Statement Of Work

Fuel Cells

- Collect data from the Fuel Cell Monitor PCM
- Convert Fuel Cell Monitor data into Shuttle Data Streams.
 - Provide a PCM Decom for the new Fuel Cell Data.
 - Provide a Shuttle Data Stream form the Fuel Cell Decom
- Consolidated Fuel Cell Monitor data in the Consolidated System Gateway and merge into Shuttle Data Stream Prime.
- Add Fuel Cell FDs to the Data Bank
- Build PCGOAL Display for Fuel Cell Monitor systems
- Build sample CLCS Display for Fuel Cell Monitor systems

LIVIS/ CWLIS

- Investigate the methods for integrating LIVIS/ CWLIS data into the Consolidated Data Stream, CLCS, and Shuttle Data Center . This should include what data goes where and how to get it there.
- *Collect data from the LIVIS/ CWLIS.(Atlas).*
- *Convert LIVIS/ CWLIS data into Shuttle Data Streams. .(Atlas).*
 - *Provide a data collection box for the new LIVIS collection units. .(Atlas).*
 - *Provide a Shuttle Data Stream from the LIVIS collection box. .(Atlas).*
- *Consolidated LIVIS/CWLIS data in the Consolidated System Gateway and merge into Shuttle Data Stream Prime. .(Atlas).*
- *Provide command interface for LIVIS/ CWLIS system. (Atlas).*
- *Add LIVIS/CWLIS FDs to the Data Bank.(Atlas)*
- *Build PCGOAL Display for LIVIS/ CWLIS systems(Atlas.*
- *Build sample CLCS Display for LIVIS/ CWLIS systems. (Atlas*

Integrated Vehicle Health Monitoring

- Collect Integrated Vehicle Health Monitoring data.
- Convert Integrated Vehicle Health Monitoring data into:
 - Shuttle Data Streams.
 - RTCN data.
- Consolidate Integrated Vehicle Health Monitoring data in the Consolidated System Gateway and merge into Shuttle Data Stream Prime.
- Provide command interface for Vehicle Health Monitoring system..
 - Support a socket type interface between the Gateway and the HTD box (either RS422 or Ethernet)
- Define and implement the Users Displays to support the HTD.
 - Build PCGOAL Display for Integrated Vehicle Health Monitoring systems
 - Build sample CLCS Display for Integrated Vehicle Health Monitoring systems. Provide displays using SL-GMS and possibly Labviews

- Add Vehicle Health Monitoring to the Data Bank.
 - Define the HTD unique FDs and provide the system and application services to support them for the Vehicle Health Monitoring Technology Demonstration.
 - HTD1 has 30 FDs
 - HTD2 has 300 FDs
- Define and provide the hardware requirements for supporting the Vehicle Health Monitoring Technology Demonstration.
- Develop the Concept of Operations for support of the .Vehicle Health Monitoring Technology Demonstration.
- Develop schedule and plan to support . Vehicle Health Monitoring Technology Demonstration 1 during STS-95 launch (10/8/98)
- Provide data recording and retrieval support

Record Playback Subsystem

- Investigate the methods for integrating Record Playback Subsystem data into the Consolidated Data Stream, Record Playback Subsystem, and Shuttle Data Center . This should include what data goes where and how to get it there.
- Provided selected Record Playback Subsystem data to the Consolidated System Gateway.

Engine Shop

- Investigate the methods for integrating Engine Shop data with CLCS. This should include both short term plan and 5 year plan.

Backup Hazardous Gas

- Work with the Backup Hazardous Gas upgrade program to provide a data source to the Consolidate System Gateway.
 - Generate a Backup Hazardous Gas ICD to the upgrade project.
 - Receive the Backup Hazardous Gas data stream in the Consolidated System Gateway
- Add Backup Hazardous Gas FDs to the Data Bank (65)
- Consolidated Integrated Backup Hazardous Gas data in the Consolidated System Gateway and merge into Shuttle Data Stream Prime.
- Build PCGOAL Display for Backup Hazardous Gas systems

General

- Provide Shuttle Data Center retrieval for Integrated Vehicle Health Monitoring and Fuel Cell Monitor in the LCC and in the OSB
- Deploy PCGOAL Display set and data stream in FR2.
- Re-Validate the Shuttle Data Stream Prime data stream as required
- Build, load, distribute, and initialize all TCID table and SCID software required to support Consolidated System Gateway operation.

Performance Requirement from SLS

- None assigned for Thor

6.3 FOUNDATION SERVICE THREAD GROUP

- Commanding and Command Processor Phase 2 Thread
- Data Distribution Completion Thread
- Reliable Messages Completion Thread
- System Viewers Thread
- System Integrity Phase 1 Thread

6.3.1 Commanding and Command Processor Phase 2 Thread

Overview:

This thread supports commanding by cursor control, manual input, for Test Application Scripts and End item Managers. In addition, it provides the basic command processor GUI and command structure for CLCS. Although all commands will not work in the system the interface for them will be developed.

Highlights:

- Continue support for cursor commanding.
- Add support for program and script commanding.
- Add commands in addition to FD commands
- Build most Command GUIs

Statement Of Work

Command Management

- Add mode control to FD commands (override)
- Add platform routing to commands
- Add priority queue Launch Data Bus for commands
- Add initial commanding to support End Item Manager control
- Add routing of FD Commands to Prerequisite Control Logic
- Provide command interface from End Item Managers and Test Application Scripts
- Provide initial End Item Manager application to End Item Manager application commands
- Provide initial Launch Data Bus FD commands (AS, DS)
- Provide initial Launch Data Bus memory read write commands (GPC Memory Read, GPC Memory Write, Launch Data Bus Control)
- Provide Table Management commands for Ground Support Equipment Gateway
- Provide a user display capability to demonstrate FD related commands and modes.
- Provide prototype of \$CMD function for CLCS
- Define and prototype the design for command authentication processing

Command Processor

- Evaluate existing command interfaces for use of code and or methods in CLCS
 - Launch Team Training System completion editor.
 - Launch Team Training System command windows.
 - TCMS
 - CCMS 1
 - JSC
 - Others.

- Develop the list of command functions using as a basis but not limited to the SLS table.
- Develop a matrix of command methods (list select, command line, graphical, menus) and map them to command functions.
- Prototype various commanding methods and receive user feedback.
- Provide specific support for command GUIs needed by Commanding Phase 2 Thread
- Implement a set of GUIs to provide most of the command functions needed in CLCS

Performance Requirement from SLS

- The system shall support executing a manual command in less than one second from human execution to HIM output.
- The system shall provide the capability to issue commands from a single test (control) application to support every Launch Data Bus command opportunity (120 milliseconds).
- RTPS shall be able to support full Uplink command rates on the following links:
 - GSE - 500/second.

6.3.2 Data Distribution Completion Thread

Overview:

This thread provides the completion of support for end-to-end data flow of FDs. It provides the mechanism for the system to move data values between most elements of the CLCS, which include the Data Distribution Processors, Command and Control Processors, Command and Control Workstations, and the Shuttle Data Center . It supports retrieval of FD data by user applications and user displays.

Highlights:

- Provide performance data for system modeling.
- Confirm and or modify system data flow for FD Data Distribution.
- Provide the capability for the Data Distribution function to be utilized in both Operational and Desktop debug configurations.
- Add support for Application Change Data.

Statement Of Work

Data Distribution Processor Data Merge Function

- Collect Application Change Data packets from all Command and Control Processors at System synchronous rate
- Merge Gateway Change Data and Application Change Data in to a single data stream.
- Place requested FDs in queues for the Data Constraint Function
- Define and provide a method to send System Default FD Display Attributes (dynamic limits and animation).
- Maintain statistics on packet rates, data rates, and CPU utilization.

Command and Control Processor Data Function

- Provide an output queue for user Pseudo FDs and transmit them to the Data Distribution Processor at system synchronous rate.
- Define and provide a method to send System Default FD Display Attributes.
- Place requested FDs in queues for the Data Constraint Function

Shuttle Data Center Data Function

- For debug use – Record raw Gateway Change Data Packets from all gateways and Application Change Data Packets from all Command and Control Processors on the RTCN

General

- Maintain statistics on packet rates, data rates, errors and CPU utilization.
- Provide performance data for system modeling
- Confirm and or modify system data flow for FD Data Distribution
- Provide the capability for the Data Distribution function to be utilized in both Operational and Desktop Debug configurations.
- Provide logging of error, performance and state change information

- Baseline system messages using the System Message Catalog to include message and help text.

Performance Requirement from SLS

- The “system maximum data bandwidth” shall support 25,000 end item changes per second continuously.
- The system shall support 50,000 end item measurement changes in a given second without losing any data.
- The system shall support 1,000 end item measurement changes during a 10 millisecond period.
- One user’s test applications shall be able to read 10,000 measurements, and “verify” them in a single second in an unloaded system.
- The data distribution function shall support the “system maximum data bandwidth”, plus 5,000 (20%) Data Fusion updates per second.

6.3.3 Reliable Messages Completion Thread

Overview:

This thread provides the completion of the reliable delivery network capability.

Highlights:

- Performance based reliable message service.

Statement Of Work

- Implement study phase finding from Redstone.
- Maintain statistics on packet rates, data rates, errors and CPU utilization.
- Provide performance data for system modeling
- Meet all SLS performance requirements
- Conduct network reliability analysis
- Assess the feasibility of continued use of ACK base protocol for reliable message delivery and implement as per panel approval.
- Determine whether Network Services APIs should consist of a process rather than a set of Library Calls and implement as per panel approval
- Provide the capability for supporting multiple senders on a single stream (e.g. System Message Service).
- Replace static address table and its manual configuration with dynamic address allocation approach
- Complete requirements not met in Redstone.

Performance Requirement from SLS

- Derived to support other threads

6.3.4 System Integrity and Subsystem Initialization Phase 1 Thread

Overview:

This thread provides the supporting Subsystem Integrity infrastructure as a foundation for implementing System Integrity in Atlas. The focus will be in defining, transmitting/logging, and displaying Subsystem Health and performance information. The beginning of Set configurability will be implemented (i.e. ,A System Configuration Table (STC) will be defined and implemented). Modes of operation for all Subsystems will be designed and implemented for Thor. The top level design for Redundancy Management will be defined, but not implemented in Thor.

Highlights:

- Provide subsystem health.
- Provide Subsystem Initialization in every delivered Thor RTPS Subsystem

Statement Of Work

- Define standard formats for transmitting/logging Subsystem Integrity information including: summary subsystem health counter, subsystem state, health counters of strategic processes, device errors, device usage counts, strategic performance statistics.
- From RTCN based subsystems, provide Subsystem Integrity information to System Integrity at the System Synchronous Rate.
- From Command and Control Workstation, subsystems provide Subsystem Integrity information to the primary System Integrity.
- From the Data Distribution Processor, provide Subsystem Integrity information to the primary System Integrity.
- From the primary Command and Control Processor, provide aggregate Subsystem Integrity information every 1 second on the DCN to all Command and Control Workstations
- Prototype the interface between Subsystem Integrity and User Applications on Command and Control Processors and Command and Control Workstations
- Provide a System Configuration Table that defines the Subsystems that exist in the Test Set and that facilitates Redundancy Management post Thor.
- Define and implement System State of all Subsystems
- Provide a Subsystem Health Viewer
 - Provide a system status HCI display that shows overall Subsystem Integrity status of all subsystems.
 - Provide a summary level display which will show status of all subsystems on a single page.
 - Provide a single subsystem display, showing detail status of that subsystem.
 - Both displays should be automatically refreshed at the aggregate as required.
- Provide a Subsystem Initialization capability in each RTPS Subsystem
 - Define and implement real-time Process Priorities for each delivered Thor RTPS CSC.
 - Utilize the System Configuration Table to establish subsystem identification for subsystems participating in the Test Set.

Performance Requirement from SLS

- None assigned for Thor

6.3.5 System Viewers Thread

Overview:

This thread provides the methods and displays for operators to understand the system without writing application code. This delivery updated Redstone viewer and provides new viewers for Constraint Management, End Item Managers and Subsystem Integrity.

Highlights:

- Provide Data Health Viewer
- Provide Data Fusion Viewer
- Provide Constraint Management Viewer
- Provide System Message Viewer

Statement Of Work

- Collect and implement update to Redstone viewers based on user feedback.
- Evaluated porting and other impacts to use viewers in the office and BASIS environment.
- Complete implementation of Data Health Viewer.
 - Add additional Health and Status indicators
 - Add Reason Code, system indicator of why health indicator was set, Distribution and Collection
 - Utilize the System Message Catalog concept for reason Codes and associated text.
 - For a number of conditions for Health to be set, demonstrate real output for those conditions.
- Complete implementation of Data Fusion Viewer
 - Add display of function/algorithm and parameters.
 - Add display of input and output values.
 - Add display of internal values.
 - For select FDs (AM, DM, DP) provide demonstration of real viewer output
 - Gather this data atomically
- Complete System Message Viewer
 - Support SCID and TCID based System Messages.
 - Complete development of the System Message Catalog.
 - Complete development of System Message Services including access from Application Services for User and System Applications.
 - *Provide System Message Viewer Retrieval prototype.(Atlas)*
 - *Ensure System Message Viewer Retrieval has similar “look and feel” of Web-based retrievals(Atlas)*
- Provide a Constraint Viewer that lists constraints on an FD for a given Command and Control Workstation, Command and Control Processor, or Data Distribution Processor.
- Provide a Detail Constraint Viewer to view the Constraint conditions.
- Provide a Constraint Monitor Viewer which provides a mechanism for asserting and viewing constraints against measurement FDs for Constraint Monitor purposes only

- Provide the capability to view constraint violations at a summary level (for example, Launch Commit Criteria or OMRSD).
- Provide the capability for the Viewer function to be utilized in both Operational and Desktop Debug configurations.
- Continue prototype effort for DNAV replacement (Task Bar Viewer- Control Navigation System).
- Port prototype effort to BASIS environment.
- Have System Build provide NT based System Build Environment.
- Provide logging of error, performance and state change information
- Baseline system messages using the System Message Catalog to include message and help text.

Performance Requirement from SLS

- Demonstration

6.4 APPLICATION SOFTWARE THREAD GROUP

- Desktop Debug Environment Thread
- Simulation Interface Phase 2 Thread
- Near Real-time Advisory Thread
- Advanced Data Support Thread

6.4.1 Desktop Debug Environment Overview.

This thread establishes the application software Desktop Debug Environment (DDE) by building on the Redstone Test Bed Pathfinder products. Application software debug is performed jointly by the DDE and the IDE. Application software validation is performed in the IDE. The DDE provides a standalone light weight capability for individual application software developers to develop and debug all types of RTPS user application software products (including regression test scripts) from the office environment. The DDE is the application software primary debug tool and is capable of debugging the bulk of applications software. The tool is light weight and has limitations necessary to make the cost of developing the tool affordable and executable in the existing desktop office computers. The IDE provides full debug of all application software functions but is a limited resource.

Statement of Work

- Support user application software debug required to debug the vast majority of user application software in a stand-alone single user mode.
- Provide a light weight compatible user application execution support capability at the Applications Service API level *that is in sync with or leading RTPS deliveries.*
- As a design goal, utilize Application Services (Basic & Tailored) without requiring DDE unique modifications.
- Runtime compatibility with the RTPS is limited to basic functional compatibility necessary for application debug and does not extend to performance and timing compatibility.
- Relegate highest cost and/or least used debug support features to IDE/SDE to manage cost and allow support of existing office target platforms. Candidates for exclusion from DDE, in the early phases, include:
 - *LDB and onboard services (OCF) other than FD read/write. Thor: BITE, GMEM, Master/Reset, TEXT, DEUE, etc.*
 - *Viewers or other System Applications not specifically listed.*
 - *Many operations will be null (default is null): Gateway A/I, Health status, Data Fusion A/I, etc.*

DDE will be deployed in phases with incremental drops. The necessity of this implementation is due to the reliance on the delivery of the components that will be used by DDE. The strategy of this implementation is to minimize deployment overhead costs and provide the minimal configuration necessary for use by application software developers at the earliest possible date. Subsequent drops will add to the capability.

Increment 1 Thor Delivery Objective: Support S/L Displays, in read only mode, obtaining data from a null math model analogous to \$CDBFRW.

- Support S/L displays interfaced to Application Services/UDS supporting reading FD/FD Health.
- Provide system message support consisting only of output to a local disk file (no SM viewer).
- Provide DDE support for SGI/O2's.
- Provide math model support:
 - Provide a null math model capability allowing operation, as a default, without a math model.
 - Provide a limited manual command capability to include:
 - Display an FD value.

- Command an FD to a value.
- Fail an FD to a value.
- Reset a failed FD.
- *Call a math model procedure.*
- Provide a DDE Subsystem via Subsystem Build for the O2.
- Support download of necessary SCID files to the DDE.
- Support download of necessary TCID files to the DDE.
- Support modification and update in the CM Repository of user applications.
- Investigate supportability of DDE to HPUNIX workstations.

Increment 2 Thor Delivery Objective: Provide read only support to S/L displays obtaining data from SGOS and Matrix-X math models.

- Provide math model support:
 - Provide SGOS math model support by interfacing with a remote SGOS math model server (for existing SGOS math models).
 - Provide Matrix-X math model support by interfacing with a local Matrix-X math model (for existing Matrix-X math models).
 - Provide a math model tool independent interface for integrating present and future modeling tools.
 - Provide cooperative execution support for concurrent model tool use.
 - Provide a limited manual command capability to call a math model procedure.
- Provide logging to a local disk file of all FD value changes.
- Investigate supportability of DDE to HPUNIX workstations.

Increment 3 Thor Delivery Objective: Support basic EIM debug and CORBA communication between EIMs and S/L displays to EIMs.

- Support FD commands via Application Services interfaced to Command Interface API (Command Support CSCI).
- Support Command support/command interface API for supported commands.
- Provide S/L / FDS support for FD commanding.
- Provide EIM/EIM Service support for FD read/commanding.
- Provide CORBA communication interface between S/L to EIM and EIM to EIM.
- Provide C++ support model (similar to what is used for system software validation, e.g., DOI Raps to DI1) and demonstrate use with a simple wrap model.
- Investigate supportability of DDE to HPUNIX workstations.

Increment 4 Post Thor Delivery Objective: Provide basic Thor application support in DDE.

- *Provide capability to add/modify/delete FDs locally at the DDE as a debug aid (no interface/affect on DBSAFE FD definitions). Provide a report of modifications made locally to FDs to aid in manually submitting changes to DBSAFE.*
- *Provide data fusion execution support and the capability to develop Data Fusion scripts.*
- *Provide PCL execution support and the capability to develop PCL scripts.*
- *Provide modification and update in the CM Repository of Data Fusion and PCL scripts.*

- *Provide all of Thor Constraint Management capabilities in DDE.*
- *HPUX support*

Potential support for subsequent phases:

- *HMP/CMP*
- *TAS*
- *Regression Test Scripts including math model control*
- *HMP/CMP initiation/termination*
- *System Viewers: FD, Data Fusion, System Message, Constraint Management*
- *Support Application Service local logging & retrieval*
- *Provide regression test support for both DDE and user applications*

6.4.2 Simulation Interface Phase 2 Thread

Overview:

This thread supports connection of the SGOS models to the CLCS RTCN without the use of the front end gateways or Video Simulation Interface equipment.

This thread develops the capability to connect the SGOS models to the CLCS sets. The main focus of this thread will be on connectivity. The simulation system will provide a simulation gateway connection to the RTCN. The two functions supported by the Simulation gateway are to provide Gateway Change Packet(s) and support reception of Command and Control Processor Command Request Packet(s).

Highlights:

- Increased support for CLCS of measurement and command types

Statement Of Work

- All requirements are to support a single link at any one time.
- Provide for the conversion of Ground Support Equipment, PCM and Launch Data Bus measurement values to Gateway Change Packet Formats.
- Provide support for Launch Data Bus FD measurement and FD commands GPC mode by way of Command and Control Processor Command Request Packet(s). from the RTCN.
- Provide for the stimulation of most model Ground Support Equipment stimulus by way of Command and Control Processor Command Request Packet(s). from the RTCN.
- .

Performance Requirement from SLS

- Demonstration

6.4.3 Near Real-time Advisory Thread

Overview:

This thread supports advisory system capabilities for the CLCS Support Workstation and the Office Environment. The plan is for the UNIX based advisory systems to run in the Shuttle Data Center on the Advanced Application Server. The user would then become an X-Terminal to the Application from the Support Workstation or from the Office. There are some concerns regarding this implementation's effect on the performance of the individual advisory systems. There are also some concerns regarding the execution of multiple instances of these advisory systems effect on the CLCS and KSC networks. The efforts for Thor will provide resolution to these issues.

There is one Near Real-time Advisory System being implemented for Thor that is platform independent. This is the JVIEW System. JVIEW is a JAVA based version of PCGOAL. Thor should provide a good introduction of JVIEW to the CLCS community.

Highlights:

- Integrate PAT into CLCS
- Integrate APU Neural Network into CLCS
- Integrate JVIEW into CLCS

Statement Of Work

- Integrate PAT into CLCS
 - Provide initial deployment of PAT system to CLCS.
 - Using CLCS data deploy Telemetry Data Services.
- Integrate APU Neural Network into CLCS
 - Provide initial deployment of APU Neural Network system to CLCS.
 - Port to Neural Online.
 - Provide Pulse Display Capability.
- Integrate JView into CLCS
 - Provide initial deployment of JView system to CLCS.
 - Provide simple plotting support (i.e. 15 minutes)
 - Support 100 users
 - Utilize 2 second snapshot data
 - Support existing PCGOAL Display Files
 - Support 3 data streams

Performance Requirement from SLS

- None assigned for Thor
- Demonstration

6.4.4 Advanced Data Support Tools Thread

Overview:

This thread supports historical data retrieval and analysis similar to but improved upon what would be found on the CDS HI-TRAX system today. A Robust CAP Program Web Interface as well as the beginnings of the Advanced Data Analysis Tool, (ADAT), will be featured in Thor. The Phase I CLCS Retrieved Data Presentation (RDP) will be delivered.

Highlights:

- Continuation of Robust Cap Program Web Interface Deployment
- Phase I of the Advanced Data Analysis Tool, (ADAT)
- Phase I CLCS Retrieved Data Presentation

Statement Of Work

- Continuation of Robust CAP Program Web Interface
 - Some touch up on Web GUIs for CAP 104, 134, 135, 145
 - Provide Additional CAP GUIs for CAP 142, 136, 113
 - Provide Web based DSTAT Capability
 - Provide FD selection for CAPS from a scrollable list that reacts to keystrokes.
- Advanced Data Analysis Tool, (ADAT) Phase I
 - Provide initial release of ADAT that is Web Based and accessible from Operational Control Room and Office.
 - Provide Plot, Zoom and FD Value List Capability
- Phase I CLCS Retrieved Data Presentation (RDP)
 - Provide Raw Packet Retrieval and Presentation Capability
 - Provide formatted output of the packet retrieval as a raw hex dump.
 - Provide formatted output of the packet retrieval as a decoded Headers Only.
 - Provide formatted output of the packet retrieval as a field delimited partially formatted packet body dump. This is not to infer that fields need to be translated in to fully decoded messages. Field labels with appropriate hex, ASCII, binary or integer formatting is required.
 - Provide Computer-to-Computer (C-C) Retrieval and Presentation Capability
 - Provide Log Data Retrieval and Presentation Capability
 - Provide Function Designator (FD) Retrieval and Presentation Capability

Performance Requirement from SLS

- None assigned for Thor
- Demonstration

6.5 APPLICATION SUPPORT THREAD GROUP

- End Item Manager, Prerequisite Control Logic, and Application Interface Thread
- Constraint Manager Phase 1 Thread
- Data Health Completion Thread
- Data Fusion Completion Thread

6.5.1 End Item Manager, Prerequisite Control Logic and Application Interface Thread

Overview:

This thread establishes the CLCS capability to provide process control application programs, and replace the GOAL, functionality for the RTPS system. The purpose of this thread is to get the End Item Manager to full working status in the RTPS system.

The End-Item Management function provides the capability for users to create End-Item Manager applications to perform closed loop control of a specific End-Item system or component. A hierarchy of End-Item Managers will exist for large and complex End-Item Systems.

The Applications Interface Thread provides the system software capability to allow all classes of Applications Software (Display Monitors, and End Item Managers,) to communicate between one another, both within the same processor and across processors

Highlights:

- Integrate End Item Managers with RTPS

Statement Of Work

- The design/implementation will use an object-oriented paradigm to mesh with the Application Services and Applications Software design.
- Utilize inter-process object - based communication capability to directly invoke a remote object's methods.
- Provide an interface from the application to Command Management to prevent unauthorized command attempts from leaving the Command and Control Processor .
- Provide the capability to operate an End-Item using rate based control.
- Provide an interface to allow End Item Manager Tool (Control Shell)to:
 - Read and write all Thor-delivered FDs and End Item Manager Components and their attributes..
 - Receive control commands from users on a Command and Control Workstation .
 - Receive control commands from Test Application Scripts.
 - Delegate continuous monitoring to Constraint Management and respond to Constraint Management notification events.
 - Issue a command to another End-Item Manager. and receive a response
 - .
- Provide priority Reactive Sequence Control processing for End-Item Managers that Requires minimum reaction time to event notification from Constraint Management
- Provide Prerequisite Control Logic processing for End Item Managers that:
 - Allows Command Management to route to and execute Prerequisite Control Logic for user applications or user command FD commands
 - Allows Command Manager to route to and execute Prerequisite Control Logic for user applications or user command End Item Managers commands
 - Inhibit execution of the command if the Prerequisite Control Logic condition(s) are not met.

- Provide results of Prerequisite Control Logic to Command Management .
- Issue System Message if Prerequisite Control Logic condition(s) are not met.
- Provide an override to Prerequisite Control Logic for Command and Control Workstation commands.
-
- Provide a method to list which commands on which FD have Prerequisite Control Logic.
- Provide a method for overriding an FD input to a Prerequisite Control Logic application.
- Ensure system level compatibility between End Item Managers, FDs, User displays, and Prerequisite Control Logic,. Define checking and binding at compile, build, startup, and runtime.
- Provide performance data for system modeling.
- Provide the capability for End Item Manager to be utilized in both Operational and Desktop Debug configurations.
- Provide logging of error, performance and state change information
- Baseline system messages using the System Message Catalog to include message and help text.

Performance Requirement from SLS

- None assigned for Thor
- Demonstration

6.5.2 Constraint Manager Phase 1 Thread

Overview:

This thread provides the initial Constraint Management Tool. Constraint Management provides the capability to monitor Measurement FDs for a predetermined condition and notify personnel operating the Test Set and software applications executing within the Test Set that the monitored data no longer meets the predetermined condition.

Highlights:

Statement Of Work

- Define the list of *logical, mathematical, and(Atlas)* relational functions required by the users for Constraint Management
- Determine if a Control shell can be utilized and provide the selected tool.
- *Provide the initial Pre-Build Constraint Management Editor.(Atlas)*
- Provide the capability for Fused FDs to be utilized by Constraint Management
- Provide an initial API for System Viewers with the minimum capability to access Constraint.
- Provide performance data for system modeling.
- Confirm and or modify system data flow for Constraint Management.
- Define Packet formats for Constraint Management
- Provide the capability to monitor Measurement FDs at the rate the data changes and determine when constraint conditions are met.
- Provide the capability for multiple users and system or user applications to request notification of constraint events for each Measurement FD.
- *The CLCS shall provide the capability to monitor measurement data (both converted count data or calibrated engineering units) for out of limits excursions and notify registered users when any of the following conditions occurs(Atlas)*
 - *N samples in a row that meet the constraint(Atlas)*
 - *N samples in a given time that meet the constraint(Atlas)*
- *There is less than a specified time between constraint events(Atlas)*Provide the capability to access current constraints and their algorithms.
- Provide the capability to create new constraints from an application, or keyboard.
- Provide logging of error, performance and state change information
- Baseline system messages using the System Message Catalog to include message and help text.

Performance Requirement from SLS

- None assigned for Thor
- Demonstration

6.5.3 Data Health Completion Thread

Overview:

This thread provides the completion of the CLCS capability to provide health information for FDs. This Thread will support Data Health loading, processing, viewing, logging and retrieval.

Highlights:

Statement Of Work

- Provide record and retrieval capability.
- Provide demonstration of a Ground Support Equipment Analog health value.
- Provide performance data for system modeling.
- Provide interfaces for End item Managers, Test Application Scripts, Command and Control Workstation , and other application to provide reason codes and associated system messages to Data Health
- Provide the capability for the Data Health function to be utilized in both Operational and Desktop Debug Configurations.
- Provide logging of error, performance and state change information
- Baseline system messages using the System Message Catalog to include message and help text.

Performance Requirement from SLS

- The Data Health Function shall support the “system maximum data bandwidth”.

6.5.4 Data Fusion Completion Thread

Overview:

This thread provides the completion of the CLCS capability to provide information using multiple FDs to produce a new FD. (Data Fusion). This thread will support Data Fusion FD editing, building, loading, processing, distribution, system viewing, logging and retrieving.

Highlights:

- Complete and make available Data Fusion for all users

Statement Of Work

- Provide user guide that lists the logical and mathematical functions provided by Data Fusion
- Provide the Pre-Build Data Fusion Editor.
- Provide the capability to add fused FDs to the Data Bank.
- Provide the capability for Fused FDs in the Test Build process.
- Provide an API for System Viewer with the minimum capability to access Fused FDs, including the Fused FD value, associated input FD values and the function being used to generate the Fused FD.
- Provide an FD Creation Tool to allow FDs of any type to be created deleted and modified. Allow these changes to be made to an Online Data Bank without using DBSAFE.(Desktop Debug Configuration Only)
- Provide a capability to back fill these new FDs to DBSAFE.
- Create an Enumerated FD data type supporting up to 256 states.
- Provide performance data for Fusion overhead and functions for system modeling.
- Provide the capability for the Data Fusion function to be utilized in both Operational and Desktop Debug configurations.
- Coordinate with possible baseline changes for allocation of Data Fusion.
- Provide logging of error, performance and state change information
- Baseline system messages using the System Message Catalog to include message and help text.
- Provide capability for performing data fusion with queued FDs
- Provide mechanism to prioritize fusion algorithms.

Performance Requirement from SLS

- The Data Fusion function shall support the “system maximum data bandwidth” with one fusion calculation per change.
- The data distribution function shall support the “system maximum data bandwidth”, plus 5,000 (20%) Data Fusion updates per second.

6.6 SYSTEM SUPPORT THREAD GROUP

- Log Record and Retrieval Phase 1 Thread
- System Services Enhancement Thread

6.6.1 Log, Record and Retrieval Phase 1 Thread

Overview:

This thread establishes the frame work for CLCS data recording/retrieval, and to begin the migration of the retrieval process from the CCMS PDR/SPA and CDS/Shuttle Data Center to the CLCS system.

Highlights:

- Raw Packet Retrieval Service
- Computer-to-Computer (C-C) Retrieval Service
- Log Data Retrieval Service
- Function Designator (FD) Retrieval Service

Statement Of Work

- Investigate and define what data are recorded in CLCS. Including system messages, commands, data distribution, and inter application communication.
- Investigate and define where and when data are recorded.
- Investigate and define long range plan for data retrieval.
- Provide Index recording of FD data in the CLCS format on the Shuttle Data Center system.
- Provide Index retrieval service to return FD data in a format usable by Data Analysis and Presentation programs.
- Provide initial capability to retrieve CLCS FDs and provide the addition health and time information.
- Provide initial capability to retrieve for a CLCS FDs the Reason Code information for FDs with health bits set
- Provide the capability to record all CLCS supported commands.
- Provide the capability to retrieve all CLCS supported commands.
- Provide the capability to filter retrieval of CLCS supported commands by source, destination, type, and time.
- Provide the capability to record all CLCS supported System Messages.
- Provide the capability to retrieve all CLCS supported System Messages.
- Provide the capability to filter retrieval of CLCS supported System Messages by source, destination, type, and time.
- Provide the capability to record all CLCS packets.
- Provide the capability to retrieve all CLCS packets.
- Provide the capability to filter retrieve of CLCS supported packets by source, destination, type, and time.
- Investigate and design the Hardware and Software interface between RTPS and Shuttle Data Center for recording of RTPS data.

- Investigate and define the interface for RTPS Command and Control Workstations and Command and Control Processor to request and receive Retrieved Data from Shuttle Data Center

6.6.2 System Services Enhancement Thread

Overview:

This thread provides an enhancement to the system services provided in the Redstone Delivery and adds new services required for completion of the Thor Foundation Service, Application Support, and Application Software threads.

Highlights:

- Initial Access Control / Security Concept established for the Integrated Development Environment, Hypergolic Maintenance Facility , and Satellite Development Environments
- Final Platform Initialization / Remote Configuration capability
- Initial CLCS Timing Services Capability
- Inter-Application / Inter-Object communication capability established

Statement Of Work

- Define the access control and security requirements and process to be employed in the Integrated Development Environment, Hypergolic Maintenance Facility , and Satellite Development Environments. This should include:
 - Access control and resolution of user login requirements and functionality
 - Definition of security incidents / events and the audit logging capabilities associated with these events
 - Procedures for processing of audit data
- Implement the initial access control capabilities as defined above
- Identify and implement the necessary updates to the remote configuration and platform initialization services provided by System Control and Operational Configuration Management in the Redstone Delivery
- Define the timing requirements / capabilities needed in the CLCS Real-time Processing System. This should include:
 - Platform time synchronization across the Gateways, Data Distribution Processors, Command and Control Processors, and Command and Control Workstation s. The utilization of Network Time Protocol (NTP) functions should be the foundation for this service.
 - Support for UTC, GMT, Count Down Clock, and incrementing and decrementing event timers
- Identify, design and implement the initial set of timing services capabilities from the above list.
- Provide the final Operating System server and Remote Installation capabilities required in the Integrated Development Environments, Hypergolic Maintenance Facility , and Satellite Development Environments. This should consider the use of servers within the Shuttle Data Center for staging and distributing OS updates.
- Provide a system administration help desk capability for the Integrated Development Environment, Satellite Development Environments, and Hypergolic Maintenance Facility .

- Remove all dependencies in code on the Advisory Service and use System Messages instead.
- Since we are changing to a no user login concept, several services will need modifications because they depend on the user's positional ID.
- The Initialization and Termination Service need to be enhanced to support starting applications with real-time priorities and on specified CPUs.
- Provide an object based communication capability between user applications using CORBA's Interface Definition Language for interface specification This capability should be an enhancement of or a replacement for the Inter-process Communications Services (IPC) services provided in Redstone.
 - Provide a set of standard C++ class libraries.
 - *Utilize CLCS Reliable Messages packets for the transport . (Atlas)*

Performance Requirement from SLS

- None assigned for Thor

7. THOR OPERATIONAL DELIVERIES.

7.1 CONSOLIDATED SHUTTLE DATA STREAM GATEWAY TURNOVER

Overview:

This delivery is to complete the release of the Consolidated Shuttle Data Stream Gateway.

Highlights:

- Released and operational Consolidated Shuttle Data Stream Gateway

Statement Of Work

- Install Consolidated Shuttle Data Stream Gateway in operational area.
- Provide operational manual for the Consolidated Shuttle Data Stream Gateway.
- Provide operational training for the Consolidated Shuttle Data Stream Gateway.
- Perform certification test for the Consolidated Shuttle Data Stream Gateway.
- Perform Operational Readiness Review for the Consolidated Shuttle Data Stream Gateway.
- Place the Consolidated Shuttle Data Stream Gateway under operational configuration control.
- Retain hardware and software sustaining engineering
- Retain software release control.

7.2 SHUTTLE DATA CENTER CDS RE-PLATFORM

Overview:

This delivery is to provide initial use for the Shuttle Data Center as a replacement for CDS.

Highlights:

- Initial operational support for selective system.
- Deployment of Shuttle Data Center on the second floor of the LCC
- Initial software release for Shuttle Data Center

Statement Of Work

- Provide support and release the Master Retrieval Station.
- Provide approved support of retrieval for Fuel Cell, Metro and LIVIS data.
 - Demonstrate support for Fuel Cell test using PCDAP
 - Develop support for Metro.
- Make first validation release of record and retrieval software.
 - Complete System Test, User Test, and Acceptance on validation release on Serial Zero
- Make first validation release of Data Analysis Tool software.
 - Complete user acceptance of 15 CAP programs
- Begin routine support.
 - Deploy Shuttle Data Center Production set in 2P17 and 2P18.
 - Provide operational support on Shuttle Data Center Production Set.

8. CSCI NON THREAD RELATED WORK

9. THOR DELIVERY SYSTEM SOFTWARE CSCI IMPACTS

Key: X = Impact or Dependency

CSCI	CSC	Function	System Capa- bility Demo	System Stress Test	End to End Gate- way	GSE Gate- way	PCM Gate- way	LDB Gate- way	CD Gate- way	Com- mand- ing	Data Dist	Reli- able Mess- ages
System Services												
		Network Services										
		Access Control/Security										
		Logging Services										
		Local Logging Services										
		SDC Logging Services										
		Interprocess Communications										
		System Message Services										
		Timer Services										
		Initialization & Termination Services										
		Display Services										
		Utility Services (print, etc.)										
		Operating System (COTS)										
Application Services												
		FD Services										
		Subsystem Services										
		Onboard Services										
		Interapplication Communication Serv										
		Constraint Management Services										
		User Display Services										
		Data Path Services										
		Data Fusion Services										
		End Item Manager Services										
		Prerequisite Control Services										
		Test Application Script Services										
		User Advisory Services										
		Math Model Services										
		System Application Services										
Data Distribution & Processing												
		Data Distribution										
		Data Health										
		Data Fusion										
		Constraint Management										
System Viewers												
		Constraint Viewer										
		FD Viewer										
		FD Monitor										
		System Message Viewer										
		Test Applications Script Viewer										

CSCI	CSC	Function	System Capa- bility Demo	System Stress Test	End to End Gate- way	GSE Gate- way	PCM Gate- way	LDB Gate- way	CD Gate- way	Com- mand- ing	Data Dist	Reli- able Mess- ages
		Performance/Capacity Monitor										
		Command Support										
		Command Processor										
		Command Management										
		Timer Display										
		Orbiter Computation Facility (OCF)										
		System Control										
		System Integrity										
		Redundancy Management										
		Subsystem Integrity										
		Ops Configuration Manager										
		Activity Management										
		RTPS System SW Load and Init										
		Test Load										
		System & Test Load Verification										
		System Diagnostics										
		On-line Readiness Test										
		Subsystem Diagnostics										
		Common Gateway Services										
		Gateway Initialization										
		Gateway Command & Response										
		Gateway RTCN Services										
		Gateway Timer Services										
		Gateway Utility Services										
		Gateway Maintenance User Interface										
		Gateway Subsystem Integrity										
		Consolidated System Gateway Services										
		GSE Gateway Services										
		GSE Gateway Table Load										
		GSE Gateway Initialization										
		GSE Gateway HIM Hardware Test										
		GSE Gateway Command Processor										
		GSE Gateway Measurement Processing										
		GSE Gateway Issue Command										
		GSE Gateway Table Maintenance										
		GSE Gateway Fuel Cell Simulation(CITE)										
		GSE Gateway Subsystem Integrity										
		LDB Gateway Services										
		PCM D/L Gateway Services										

CSCI	CSC	Function	System Capa- bility Demo	System Stress Test	End to End Gate- way	GSE Gate- way	PCM Gate- way	LDB Gate- way	CD Gate- way	Com- mand- ing	Data Dist	Reli- able Mess- ages
		Uplink Gateway Services										
		Sim Gateway Services										
		CLCS Development Environment										
		Configuration Management Environment										
		System Software Development Tools										
		Regression Test Tools										
		User Appl SW Development Tools										
		FD Design Tool										
		TCS-S Compiler										
		System Build										
		Platform Build										
		Subsystem Build										
		DBSAFE										
		Test Build & Control										
		Table Build										
		On-Line Data Bank Build										
		FD Directory Build										
		OCF Build										
		Build Utilities										
		Load Checker										
		Cross Reference (IIU)										
		TCS-S Configurator										
		Data Recording/Archival & Retrieval										
		Data Recording/Archival & Retrieval Services										
		Data Retrieval Applications										
		SDS Services										
		SDS Client Services										
		SDS Server Services										
		Near Real-time Advisory										
		Orbiter Power Up Monitor System (OPUS)										
		APU Neural Net Tool (ANNT)										
		High Speed Display										
		Propulsion Advisory Tool (PAT)										
		Java View (JView)										
		Support Advisory										
		Robust CAP Program Web Interface (RCW)										
		Advanced Data Analysis Tool (ADAT)										
		Interfaces to COTS Packages										
		Retrieval Data Presentation (RDP)										

CSCI	CSC	Function	System Inte- grity	Viewers	EIM	Sim Gate- way	Real time Advi- sory	Ad- vance Re- trieval	Con- strain Man- ager	Health	Fusion	Record
System Services												
		Network Services										
		Access Control/Security										
		Logging Services										
		Local Logging Services										
		SDC Logging Services										
		Interprocess Communications										
		System Message Services										
		Timer Services										
		Initialization & Termination Services										
		Display Services										
		Utility Services (print, etc.)										
		Operating System (COTS)										
Application Services												
		FD Services										
		Subsystem Services										
		Onboard Services										
		Interapplication Communication Serv										
		Constraint Management Services										
		User Display Services										
		Data Path Services										
		Data Fusion Services										
		End Item Manager Services										
		Prerequisite Control Services										
		Test Application Script Services										
		User Advisory Services										
		Math Model Services										
		System Application Services										
Data Distribution & Processing												
		Data Distribution										
		Data Health										
		Data Fusion										
		Constraint Management										
System Viewers												
		Constraint Viewer										
		FD Viewer										
		FD Monitor										
		System Message Viewer										
		Test Applications Script Viewer										

CSCI	CSC	Function	System Inte- grity	Viewers	EIM	Sim Gate- way	Real time Advi- sory	Ad- vance Re- trieval	Con- strain Man- ager	Health	Fusion	Record
		Performance/Capacity Monitor										
		Command Support										
		Command Processor										
		Command Management										
		Timer Display										
		Orbiter Computation Facility (OCF)										
		System Control										
		System Integrity										
		Redundancy Management										
		Subsystem Integrity										
		Ops Configuration Manager										
		Activity Management										
		RTPS System SW Load and Init										
		Test Load										
		System & Test Load Verification										
		System Diagnostics										
		On-line Readiness Test										
		Subsystem Diagnostics										
		Common Gateway Services										
		Gateway Initialization										
		Gateway Command & Response										
		Gateway RTCN Services										
		Gateway Timer Services										
		Gateway Utility Services										
		Gateway Maintenance User Interface										
		Gateway Subsystem Integrity										
		Consolidated System Gateway Services										
		GSE Gateway Services										
		GSE Gateway Table Load										
		GSE Gateway Initialization										
		GSE Gateway HIM Hardware Test										
		GSE Gateway Command Processor										
		GSE Gateway Measurement Processing										
		GSE Gateway Issue Command										
		GSE Gateway Table Maintenance										
		GSE Gateway Fuel Cell Simulation(CITE)										
		GSE Gateway Subsystem Integrity										
		LDB Gateway Services										
		PCM D/L Gateway Services										

CSCI	CSC	Function	System Inte- grity	View-ers	EIM	Sim Gate- way	Real time Advi- sory	Ad- vance Re- trieval	Con- strain Man- ager	Health	Fusion	Record
Uplink Gateway Services												
Sim Gateway Services												
CLCS Development Environment												
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Table Build												
On-Line Data Bank Build												
FD Directory Build												
OCF Build												
Build Utilities												
Load Checker												
Cross Reference (IIU)												
TCS-S Configurator												
Data Recording/Archival & Retrieval												
Data Recording/Archival & Retrieval Services												
Data Retrieval Applications												
SDS Services												
SDS Client Services												
SDS Server Services												
Near Real-time Advisory												
Orbiter Power Up Monitor System (OPUS)												
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High Speed Display												
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Java View (JView)												
Support Advisory												
Robust CAP Program Web Interface (RCW)												
Advanced Data Analysis Tool (ADAT)												
Interfaces to COTS Packages												
Retrieval Data Presentation (RDP)												

10. THOR DELIVERY APPLICATION SOFTWARE CSCI IMPACTS

CSCI	CSC	Function	SLWT	HMF FRCS	HMF ROMS	HMF LOMS	Power Up / Down
Common App Support							
		SL-GMS Components	X	X	X	X	X
		End Item Components		X	X	X	X
		HMP/CMP Components		X	X	X	x
		Generic Components		X	X	X	X
		APU					
		HYD					
		COMM					
		NAV					
		DPS					X
		DPSME					
		ECLSS					X
		ECS					
		EPDC					X
		GLS					
		GUID					
		HAZ GAS	X				
		BHYD					
		BAPU					
		INST					X
		Swing Arm					
		LH2	X				
		LO2	X				
		HMF		X	X	X	
		MSTR					
		METRO	X				
		MEQ					
		MPS					
		SSME					
		OMS/RCS					
		FLT CONTROLS					
		PLDTEST					
		PRSD/FC					
		SLWT	X				
		SRSS					
		Water					
		CITE					
		CCS					
		Power					
		Water					
		Pneumatics					
		HVAC					